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SUPPLEMENTAL RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION REPORT FOR HIGH PRIORITY SITES TEXT NAS KEY WEST FL

7/1/1997

BROWN AND ROOT ENVIRONMENTAL

Supplemental RCRA Facility Investigation and Remedial Investigation Report

0002

for

Naval Air Station Key West High-Priority Sites

Boca Chica Key, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0007

July 1997

Brown & Root Environmental

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SUPPLEMENTAL RCRA FACILITY INVESTIGATION AND REMEDIAL INVESTIGATION REPORT

NAVAL AIR STATION KEY WEST HIGH-PRIORITY SITES BOCA CHICA KEY, FLORIDA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

TABLES

NUMBER **PAGE**

TABLE OF CONTENTS (Continued)

TABLES

TABLE OF CONTENTS (Continued)

FIGURES

TABLE OF CONTENTS (Continued)

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS
NAS KEY WEST SUPPLEMENTAL RFI/RI

AA	Atomic Absorption
ABB	ABB Environmental Services, Inc.
ABSEFF	Absorption efficiency
ACGIH	American Conference of Governmental Industrial Hygienists
AIMD	Aircraft Intermediate Maintenance Department
AOC	area of concern
AL	action level
APHA	American Public Health Association
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AVS	acid volatile sulfide
AWQC	ambient water quality criteria
BB&L	Blasland Bouch & Lee
BCF	bioconcentration factor
BEI	Bechtel Environmental, Inc.
BHC	benzene hexachloride
BLS	below land surface
B&R Environmental	Brown & Root Environmental
BTAG	BioTechnical Assistance Group
BTEX	benzene, toluene, ethylbenzene, and xylene
BTV	benchmark toxicity value
CAL	corrective action level
CAMP	Corrective Action Management Plan
CAPCOA	California Air Pollution Control Officers Association
CAR	Contamination Assessment Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
cm	centimeter
CMS	Corrective Measures Study
cm/sec	centimeters per second
CNS	central nervous system
COC	chemical of concern
COPC	chemicals of potential concern
CRDL	contract-required detection limit
CWA	Clean Water Act
DAD	dermally absorbed dose
DCA	dichloroethane
DCB	dichlorobenzene
DCE	dichloroethene
DCP	dichloropropane
DDD	dichlorodiphenyl dichloroethane

DDE	dichlorodiphenyl dichloroethylene
DDT	dichlorodiphenyl trichloroethane
DI	deionized
DO	dissolved oxygen
DOD	United States Department of Defense
DOT	United States Department of Transportation
DQO	Data Quality Objectives
EC	electrical conductivity
ECG	electrocardiograph
ECPC	ecological contaminants of potential concern
ECC	ecological contaminants of concern
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ER-L	Effect Range-Low
ER-M	Effect Range-Medium
ESA	Endangered Species Act
ESI	EnviroSystems, Incorporated
ET	ecological threshold
eV	electron-volt
FAC	Florida Administrative Code
FDA	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Fresh Water Fish Commission
FID	flame ionization detector
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FKAA	Florida Keys Aqueduct Authority
FNAI	Florida Natural Areas Inventory
FOC	fractional organic carbon
FOL	Field Operations Leader
FOSL	Finding of Suitability to Lease
FS	Feasibility Study
FSWQS	Florida Surface Water Quality Standards
ft/ft	foot per foot
FWS	Fish and Wildlife Service (U.S. Department of the Interior)
GC	Guidance Concentration
GC/MS	gas chromatography/mass spectrometry
GI	gastrointestinal
gpd/ft^2	gallons per day per square foot
GPS	Global Positioning System
GW	groundwater
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	Hazard Index
HQ	hazard quotient
HSA	hollow stem auger
HSWA	Hazardous and Solid Waste Amendments
IARC	International Agency for Research on Cancer
IAS	Installation Assessment Study

IDL	instrument detection limit
IDW	investigation-derived waste
IEUBK	Integrated Exposure and Uptake Biokinetic
IR	Installation Restoration
IRA	Interim Remedial Action
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IT Corporation	International Technology Corporation
LCS	laboratory control sample
LNAPL	light nonaqueous phase liquids
LOAEL	Lowest-Observed-Adverse-Effect-Level
LOEL	Lowest-Observed-Effect-Level
m	meter
MCL	maximum contaminant level
MDL	method detection limit
meq/g	milliequivalent per gram
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
mS/cm	millisiemens per centimeter
µg/dL	micrograms per deciliter
µg/L	micrograms per liter
µg/kg	micrograms per kilogram
MGD	million gallons per day
MS	matrix spikes
MSD	matrix spike duplicates
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standard
NACIP	Naval Assessment and Control Installation Pollutants Program
NAS	Naval Air Station
NAVFACENGCOM	Naval Facilities Engineering Command-Southern Division
NCI	National Cancer Institute
NCP	National Contingency Plan
NEESA	Naval Energy and Environmental Support Activity
NFA	no further action
NPL	National Priority List
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observed-Adverse-Effect-Level
NOEL	No-Observed-Effect-Level
NTP	National Toxicology Program
NTUs	nephelometric turbidity units
OME	Ontario Ministry of the Environment
ORNL	Oak Ridge National Lab
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OVA	organic vapor analyzer
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PID	photoionization detector

PM	particulate matter
PNA	polynuclear aromatic
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PQLs	practical quantitation limits
PRE	Preliminary Risk Evaluation
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAC	Remedial Action Contractor
RAGS	Risk Assessment Guidance for Superfund
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended dietary allowances
RFA	RCRA Facility Assessment
RfC	reference concentration
RfD	reference dose
RFI	RCRA Facility Investigation
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RGO	remedial goal option
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
RPD	relative percent difference
RPRG	residential/preliminary remediation goal
RTECS	Registry of Toxic Effects of Chemical Substances
SAL	screening action level
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SB	soil boring
SCG	soil cleanup goals
SDWA	Safe Drinking Water Act
SF	Slope Factor
SMDPs	Scientific/Management Decision Points
SOP	standard operating procedure
SOW	statement of work
SPT	standard penetration test
SQB	sediment quality benchmark
SQC	sediment quality criteria
SS	surface soil
SSC	Species of Special Concern
SVOC	semivolatile organic compound
SW	surface water
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TBC	to be considered
TCA	trichloroethane
TCDD	tetrachlorodibenzodioxin
TCE	trichloroethene
TCL	Target Compound List

TCLP	Toxicity Characteristic Leaching Procedure
TCFM	trichlorofluoromethane
TDS	total dissolved solids
TEFs	toxicity equivalence factors
TIC	tentatively identified compound
TOC	total organic carbon
TRPH	Total Recoverable Petroleum Hydrocarbons
TUF	Total Uncertainty Factor
UCL	Upper Confidence Limit
UF	Uncertainty Factor
USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UTL	Upper Tolerance Limit
VOC	volatile organic compound
WQS	Water Quality Standards

EXECUTIVE SUMMARY

This report presents the results of a Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) at Naval Air Station (NAS) Key West on behalf of the U.S. Navy, Naval Facilities Engineering Command, Southern Division (NAVFACENGCOM-Southern Division). The report covers the investigation of four high-priority sites [Solid Waste Management Units (SWMUs) 1, 2, 3, and 9] and Boca Chica Key background locations. Brown & Root Environmental (B&R Environmental) performed this Supplemental RFI/RI in accordance with a work plan for the supplemental investigation of 15 sites approved by the U.S. Environmental Protection Agency (EPA) and the Florida Department of Environmental Protection (FDEP). The sites covered in this document received a high priority based on the relative risk ranking system used by NAVFACENGCOM-Southern Division.

IT Corporation performed the initial RFI/RI investigation of sites at NAS Key West from 1992 to 1994 and reported the results to EPA and FDEP in 1994. In commenting on the initial RFI/RI, the regulatory agencies noted three overlying information needs that led to preparation of the Supplemental RFI/RI:

- The characterization of the nature and extent of contaminants is incomplete
- Characterization of the ecological risk caused by sites should be based on quantitative ecological sampling and analyses rather than biological inventories and qualitative assessments
- Sitewide background data on contaminants of concern should be provided to supplement existing site-specific background data

These areas are the focus of this Supplemental RFI/RI Report, which contains a complete assessment of the nature and extent of contamination; a human health risk assessment; an ecological risk assessment based on substantial biota sampling and analyses of biological tissue; and a thorough sitewide background study of Boca Chica Key.

NAVFACENGCOM-Southern Division directed interim removal actions at the four priority sites in 1995 and early 1996 pursuant to the delineation of contamination noted in the initial RFI/RI and other preliminary studies.

B&R Environmental used the data generated by past studies at NAS Key West in the risk assessments and other conclusions of this report. Because B&R Environmental sorted these data to remove samples from areas excavated as part of the 1995 and 1996 interim removal actions, the conclusions of this report are applicable to the site conditions as they presently exist after removal of contaminated soil.

The final purpose of RFI/RI activities at NAS Key West is to provide data that the Navy will use to:

- Characterize the nature and extent of releases from the sites
- Characterize potential pathways of contaminant migration in the soil, surface water, and groundwater
- Identify potential receptors
- Assess potential risks to human health and the environment
- Determine if contaminants released from the sites require further corrective measures to mitigate the risk to human health or the environment

The RFI/RI report has been organized into four major chapters and several appendixes. Chapter 1 provides a detailed description of the discovery of installation restoration sites at NAS Key West and the progress of these investigations and cleanups. Chapter 1 also explains the need for and the scope of this Supplemental RFI/RI. Chapter 2 provides an overview of the investigation procedures, data interpretation and presentation methods, and data quality assessment protocols used during the RFI/RI. Chapter 3 provides the base environmental setting.

The results of the RFI/RI are presented in Chapter 4, in which SWMUs 1, 2, 3, and 9 are discussed in Section 4.1, 4.2, 4.3, and 4.4, respectively. Each section contains a description of the nature and extent of contamination, and is followed by the human health risk assessment, the ecological risk assessment, and closes with a discussion of conclusions and recommendations.

The nature and extent subsections of Chapter 4 present the contaminants detected at the site, the spatial and (if applicable) temporal extent to which contaminants have impacted environmental media, and the relationship between the findings and the activities that occurred during base operations. The detected contaminants were compared to applicable or relevant and appropriate requirements (ARARs) and screening action levels (SALs) for each medium (soil, sediment, surface water and groundwater). This approach provides the reader with a quick overview of the distribution and extent of site contaminants that were detected and identifies areas of greatest impact. Figures (i.e., maps of each site) accompany the text to provide the reviewer with a frame of reference regarding site contamination. The approach presented in the text and figures in the "Nature and Extent" sections of the report is a conservative method in which the reader is presented information showing which chemicals most greatly exceed certain standards of protection (i.e., ARARs and SALs). The comparison of measured concentrations to background concentrations was accomplished in the human health and ecological risk assessments, which are presented in each section following a discussion of contaminant fate and transport.

As mentioned above, several appendices are included in the report. While titles of all appendices can be found in the report's table of contents, a brief description of three appendices is in order. Investigation procedures (i.e., methods) are presented in Appendix G (Field Procedures). Within Appendix G, procedures for data quality assessment are presented in Section 2.0, while methods for the human health and ecological risk assessments are presented in Sections 3.2 and 3.3, respectively, of Appendix G. The development and use of the background data set can be found in Appendix J (Background Report for Boca Chica Key). Laboratory analytical reports are included in Appendix L, Volumes 1-3.

For the Boca Chica background sites, this Supplemental RFI/RI produced the following results:

- With the exception of lead and arsenic in soil, concentrations of contaminants in surface water, sediment, and soil at the background locations were low in relation to ambient quality standards (soil levels of lead and arsenic were slightly higher in the background areas, possibly due to native soil levels, ubiquitous contamination or both factors).

- Concentrations of contaminants in fish and oyster tissue at the background locations were generally within the range of values considered to be normal. [The concentration of pyridine (a coal-tar derivative possibly used in underwater preservatives/coatings), however, is above normally expected levels in oyster tissue].

Table ES-1 summarizes conclusions for the four high-priority SWMUs. The table shows: whether significant contamination remains in surface water, sediment, soil, and groundwater; whether ecological or human health risks exist; and whether a corrective measures study is warranted. Suggestions as to the possible need for further corrective action are also noted.

SWMU 1, after the removal of over 6,000 cubic yards of contaminated sediment and soil in early 1996, still has contamination remaining in all media. Most significantly, there are spotty areas of soil contamination

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TABLE ES-1

SUMMARY CONCLUSIONS
NAS KEY WEST

Site	Residual Contamination After Interim Removals				Ecological Risk	Human Health Risk	Study Recommended	Corrective Action
	Surface Water	Sediment	Soil	Ground-water				
SWMU 1	Yes	Yes	Yes	Yes	Yes (limited)	Yes for residential scenario	Yes	Possible
SWMU 2	No	Yes	Yes	Yes	Yes	Possible for residential and trespasser scenarios	Yes	Monitor fish and groundwater to measure improvement following Spring 96 source removal
SWMU 3	No	No	No	No	No	No	No	No
SWMU 9	No	No	Yes	Yes	No	No	Yes to validate pump and treat remedy	Continue pump and treat; evaluate groundwater improvement

remaining and groundwater in excess of screening levels. The ecological risk and human health risk posed by the site necessitate that a corrective measure study be completed. Additional soil removal, and treatment or mitigation of groundwater contamination may be necessary corrective measures.

SWMU 2 was the subject of an extensive sediment and soil removal action in Spring 1996. Only traces of sediment contamination remain, and little contaminated soil is left exceeding screening levels. Although groundwater is still elevated in levels of DDT and its metabolites, and fish have been ecologically impacted, the source of this contamination has now been removed. A corrective measures study has been recommended to evaluate additional mitigation measures which should include continued future ecological monitoring to show recovery in fish and groundwater monitoring to show natural attenuation.

SWMU 3 was the subject of a soil removal action in 1995. The site poses no current or future ecological or human health risk, and it is recommended that SWMU 3 be approved for no further action (NFA).

SWMU 9 currently has low-level contamination of groundwater with constituents of fuel and chlorinated solvents. A pump-and-treat system has been installed and started up in July 1996 to remediate groundwater. A corrective measure study is recommended to evaluate the effectiveness of the pump-and-treat system.

1.0 INTRODUCTION

Brown & Root Environmental (B&R Environmental) has performed a Supplemental Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) at the Naval Air Station (NAS) Key West on behalf of the U.S. Navy, Naval Facilities Engineering Command, Southern Division (NAVFACENGCOM-Southern Division). B&R Environmental completed this Supplemental RFI Report under Comprehensive Long-Term Environmental Action - Navy (CLEAN) Contract Number N62467-94-D-0888, Contract Task Order 0007.

The RFI/RI process will determine if sites at a facility such as NAS Key West can eliminate a site from further consideration, if the site will require further investigation, or if the site will require the selection of appropriate remediation through a corrective measures study (CMS).

B&R Environmental performed this work to supplement the RFI/RI (Phase 1) conducted by IT Corporation from 1992 through 1994, which confirmed the presence of contamination at specific NAS Key West sites. In addition to the characterization of ecological consequences of contamination at the sites, the purpose of this supplemental investigation is to delineate the nature and extent of contamination at the station's Solid Waste Management Units (SWMUs), Installation Restoration (IR) sites, and Areas of Concern (AOCs), and to define Boca Chica Key and Key West background levels.

A total of 15 sites are to be addressed in the installation restoration program at NAS Key West. These include nine SWMUs, four IR sites, and two AOCs. Because two SWMUs are operating permitted sites, their investigation will not occur under the RFI/RI program. The RCRA corrective action program for the nine SWMUs is being implemented in accordance with RCRA and NAS Key West Hazardous and Solid Waste Amendments (HSWA) Permit No. FL6-170-022-952 issued by the U.S. Environmental Protection Agency (EPA) on July 31, 1990, and effective until August 30, 2000. The Remedial Investigation and Feasibility Study (RI/FS) activities for the IR sites are being implemented in accordance with the National Contingency Plan (NCP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA).

This report documents the supplemental investigation of four high-priority sites (SWMUs 1, 2, 3, and 9), and the investigation of the Boca Chica-wide background locations. These four SWMUs received high-priority status as a result of the relative-risk ranking of sites conducted by NAVFACENGCOM-Southern Division. Sampling was conducted for these high-priority sites and background locations in January 1996. Investigation of the remaining SWMUs, IR sites, and AOCs on Key West and nearby islands will begin in late 1996. The Supplemental RFI/RI was conducted pursuant to the HSWA portion of Permit No. HO44-144053 issued by EPA. B&R Environmental performed the investigation in accordance with the Supplemental RFI/RI workplan prepared by ABB Environmental Services, Inc. (ABB, 1995a). This report completes the investigation of NAS Key West high-priority sites, which began with a preliminary remedial investigation (IT Corporation, 1991) and an initial RFI/RI (IT Corporation, 1994).

1.1 BACKGROUND

The EPA and Florida Department of Environmental Protection (FDEP) oversee the Navy environmental program at NAS Key West. All aspects of the program are conducted in compliance with State and Federal regulations as enforced by these regulatory agencies.

1.1.1 Installation Restoration Program

The IR program was initiated by the Department of Defense (DOD) to protect public health and the environment through the investigation and remediation of conditions related to contamination resulting from past waste management and disposal activities. In 1975, the U.S. Army developed a pilot program to investigate past disposal sites at military installations. In 1980, DOD developed the IR program from the Army program and instructed the services to comply with IR program guidelines. The IR program complies with CERCLA as amended by the SARA, RCRA, and HSWA of 1984. NAS Key West has had an active IR program since 1985.

1.1.2 RCRA/HSWA Corrective Action Program

The RCRA/HSWA corrective action program was adopted to identify the measures to be taken for investigating a facility that may have released contamination into the environment. RCRA, which ensures the management of solid and hazardous wastes in an environmentally sound manner, applies to facilities that generate or handle hazardous waste. The HSWA corrective action program is designed to identify and clean up releases of hazardous substances at RCRA-permitted facilities. The RCRA/HSWA program has four components: the RCRA Facility Assessment (RFA), RFI, CMS, and Corrective Action.

A Corrective Action Program Management Plan was prepared to outline the strategy for finalizing completion of the RFI/RI assessment to confirm and characterize the nature and extent of releases of hazardous substances to the environment at NAS Key West (B&R Environmental, 1997). All SWMUs at NAS Key West, except the currently operating units which are regulated by current permit conditions, are addressed by the RCRA/HSWA corrective action program.

1.1.3 CERCLA Remedial Investigation

The cleanup activities for the IR Program not addressed by a RCRA/HSWA program are being implemented in accordance with the NCP and CERCLA as amended by SARA. CERCLA establishes the approach to address and clean up hazardous waste sites at both private and Federal facilities. These investigations are commonly known as RIs. The CERCLA program applies to IR sites not designated as SWMUs.

1.2 INSTALLATION DESCRIPTION

NAS Key West is in southern Monroe County, Florida, on Boca Chica Key. Key West, one of the two westernmost major islands of the Florida Keys, is approximately 150 miles southwest of Miami. Key West is connected to the mainland by the Overseas Highway (U.S. Highway No. 1). Figure 1-1 is a regional map showing the location of Boca Chica Key and Key West within the Florida Keys. Several installations in various parts of the lower Florida Keys comprise what is known as the Naval Complex at Key West. Most of these are on Key West and Boca Chica Key. Other parts of the complex include Trumbo Point, Sigsbee Key (formerly Dredgers Key), Fleming Key, Demolition Key, Truman Annex on Key West, and Big Coppitt Key. The entire complex encompasses approximately 5,000 acres. Boca Chica Key is approximately 3 miles wide and 3 miles long, and the air station encompasses 3,250 acres. The elevations of Boca Chica Key are less than 5 feet above mean sea level (msl) with the exception of filled areas that underlie the Overseas Highway (IT Corporation, 1994).

At present, NAS Key West maintains aviation operations, a research laboratory, communications intelligence, counternarcotics air surveillance operations, a weather service, and several other activities. In addition to the Naval activities and units, other DOD and Federal agencies at NAS Key West include U.S. Air Force squadrons, a U.S. Army Special Forces Division, U.S. Coast Guard, and a Defense Property Disposal Office.

Key West is approximately 4 miles long and 1.5 miles wide. The City of Key West, which is the county seat of Monroe County, has a residential population of 24,832 (USCBS, 1990). The principal industry is tourism, with about 1,225,000 tourists visiting annually. The major sources of employment in Key West are tourism, fishing, wholesale and retail trade, services, construction, finance, insurance, real estate, Federal government, state and local government, and transportation industries.

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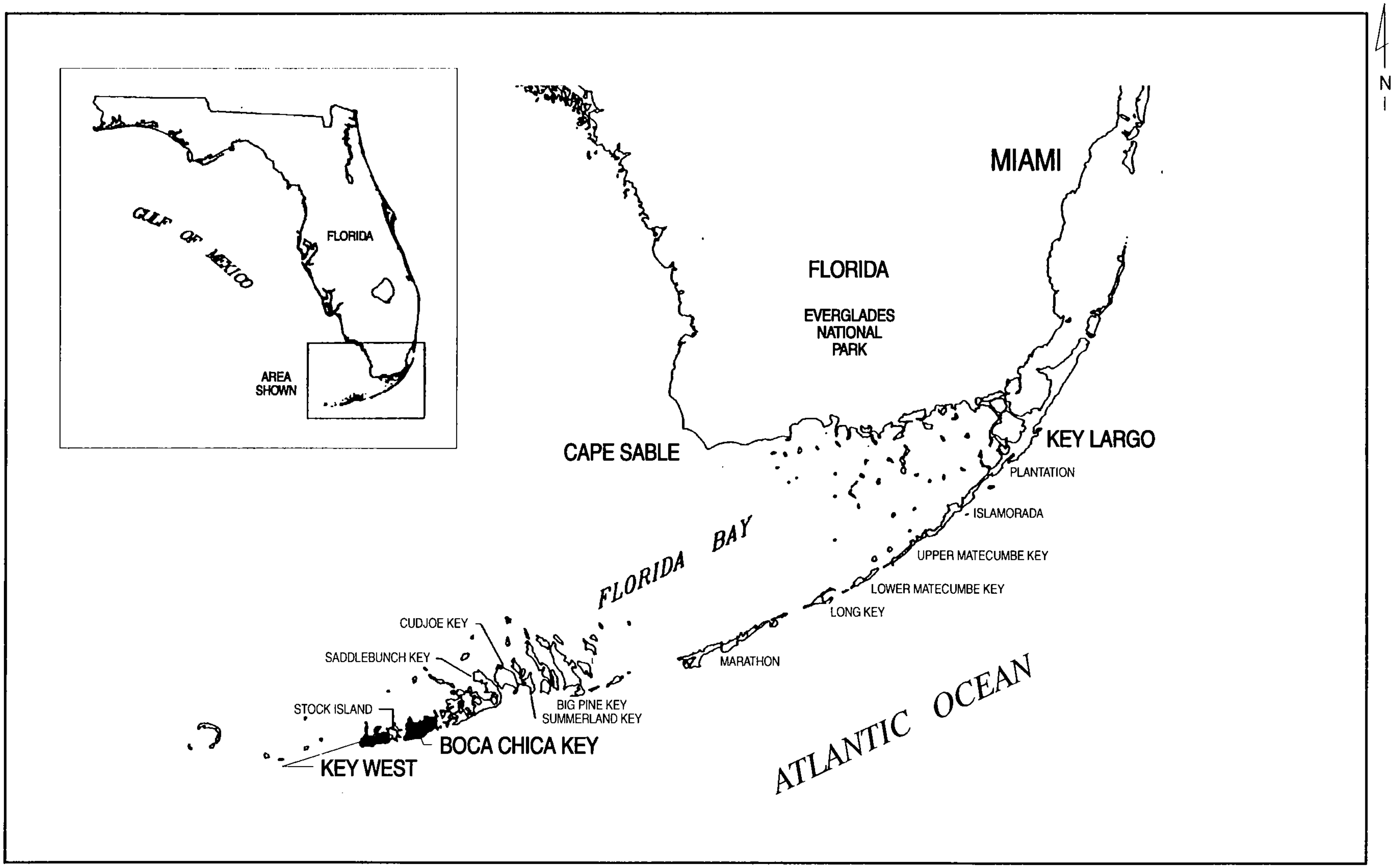

Brown & Root Environmental

0 20 40
SCALE IN MILES

FIGURE 1-1. FACILITY LOCATION MAP
NAS KEY WEST

NAS KEY WEST		KEY WEST, FLORIDA	
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1.3 INVESTIGATIVE HISTORY

Several investigations have been performed at NAS Key West since the mid-1980s to confirm or characterize contamination. This section summarizes each study and describes interim remedial actions that occurred at several sites in 1995 and 1996.

1.3.1 Previous Investigations

Based on historic data, aerial photographs, field inspections, and personnel interviews, eight potentially contaminated sites were identified at NAS Key West. As part of the Naval Assessment and Control of Installation Pollutants Program (NACIP), an Initial Assessment Study (IAS) was performed by Envirodyne Engineers, Inc., at NAS Key West in 1985 (Envirodyne Engineers, 1985). Each of the eight potentially contaminated sites was evaluated with regard to contamination characteristics, migration pathways, and pollutant receptors. As a result, a study to confirm or deny suspected contamination by sampling and monitoring was recommended for the six sites listed below in decreasing order of priority:

- Site 2: Transformer Oil Disposal Area
- Site 8: South Fleming Key Landfill
- Site 4: Boca Chica Open Disposal Area
- Site 3: Truman Annex DDT Mixing Area
- Site 1: Truman Annex Refuse Disposal Areas
- Site 5: Boca Chica DDT Mixing Area

After the completion of the IAS report, three more sites were recommended for investigation based on additional information collected:

- Site 7: Fleming Key North Landfill
- Site 9: Trumbo Point Bulk Fuel Storage Area
- Site 10: Boca Chica Fire-Fighting Training Area

The verification phase of the NACIP confirmation study was performed in 1986 by Geraghty and Miller (Geraghty & Miller, 1987). This study verified the presence or absence of shallow groundwater and soil contamination at the various sites, and recommended sites that needed further site-specific investigations during the characterization phase of the confirmation study.

In April 1988, a visual site inspection conducted by the EPA at NAS Key West as part of the RFA process (EPA, 1988) identified seven SWMUs at NAS Key West:

- SWMU 1: Boca Chica Open Disposal Area
- SWMU 2: Boca Chica DDT Mixing Area
- SWMU 3: Boca Chica Fire-Fighting Training Area
- SWMU 4: Aircraft Intermediate Maintenance Department AIMD Building A980
- SWMU 5: AIMD Building 990
- SWMU 6: Wastewater Treatment Plant
- SWMU 7: Former Hazardous Waste Storage Building A-824

Building A-824 (SWMU 7) had been used to store hazardous waste. The consulting firm of Blasland, Bouck and Lee (BB&L) performed a final series of cleanup activities of the building and the surrounding area that ended on March 29, 1991. The building currently houses a solvent recycling operation and stores empty 55-gallon drums and old transformers.

EPA prepared a draft RFA report in 1988 that recommended SWMUs 1 through 6 for an RFI under the HSWA permit. That report recommended that contamination adjacent to the RCRA Hazardous Waste Storage Area be addressed as a release from a SWMU rather than as part of the closure of the unit.

A preliminary remedial investigation report was prepared by IT Corporation (IT Corporation, 1991). This investigation evaluated potential contaminant sources at eight NAS Key West sites. The objectives included an assessment of the risk to the environment and human health and a determination of the necessity for remedial actions.

From October 1993 to February 1994, a petroleum contamination assessment of the Jet Engine Test Cell, Building A969 (SWMU 9) was conducted by ABB. The contamination assessment report (ABB, 1994) identified petroleum and 1,2-dichloroethene contamination in groundwater.

An additional assessment of groundwater at the Jet Engine Test Cell (SWMU 9) was conducted by Bechtel Environmental, Inc. (BEI) in 1995 to complete the characterization of the extent of groundwater contamination and to perform aquifer tests to support evaluation of a pump-and-treat system (BEI, 1995b).

In 1993, IT Corporation conducted soil, surface-water, sediment, and groundwater sampling at all SWMUs and IR sites as part of the first full RFI/RI sampling program. These activities were reported in the RFI/RI Final Report (IT Corporation, 1994).

The RFI/RI Report recommended remedial actions to remove impacted soil at several sites. Prior to beginning excavation and treatment/disposal activities at the sites in question (SWMU 1, SWMU 2, SWMU 3, SWMU 7, AOC A, AOC B, IR 1 and IR 3), it was necessary to gather detailed data in order to identify the appropriate limits of the excavation and meet transportation and disposal requirements for the excavated material. A delineation investigation was conducted by BEI between February and September of 1995 in order to gather this information. Soil, sediment, and surface water samples were analyzed and the horizontal and vertical excavation boundaries were determined by comparing the results to established cleanup levels. Following the delineation study, Interim Remedial Actions were undertaken by BEI.

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Table 1-1 lists the sites mentioned above and summarizes known or suspected contaminants and site status. Figure 1-2 shows the locations of the installation restoration sites.

As listed in Table 1-1, 15 sites requiring investigation activities or remediation/closure have been identified at NAS Key West. The four sites of highest priority (SWMUs 1, 2, 3, and 9), all of which are on Boca Chica Key, are addressed in this report.

1.3.2 Current Investigations

The scope of the Supplemental RFI/RI is summarized in Section 1.4. Concurrent with the Supplemental RFI/RI, BEI performed confirmational sampling on soils and sediments in order to verify the removal of impacted soil by the Interim Remedial Actions. Generally, confirmation samples were collected from the side walls of the excavation and, in some cases, this resulted in the removal of additional soil. A final report on the confirmational sampling activities had not been issued at the time of the Supplemental RFI/RI; however, data was provided by BEI and was included in this report.

Table 1-2 lists the status of Interim Remedial Actions at all IR sites as of July 29, 1996.

1.4 SUPPLEMENTAL RFI/RI SCOPE AND OBJECTIVES

1.4.1 Scope of the Supplemental RFI/RI Report

The purpose of this Supplemental RFI/RI report for NAS Key West is to present information that (1) characterizes the nature and extent of releases of hazardous wastes or contaminants from SWMUs 1, 2, 3, and 9; (2) characterizes Boca Chica Key background conditions; (3) characterizes potential pathways of contaminant migration in the soil, surface water, sediment, and groundwater; (4) identifies potential receptors; (5) assesses potential risks to human health and the environment; and (6) determines if contaminants released from a SWMU require further corrective measures to mitigate the risk to human health or the environment.

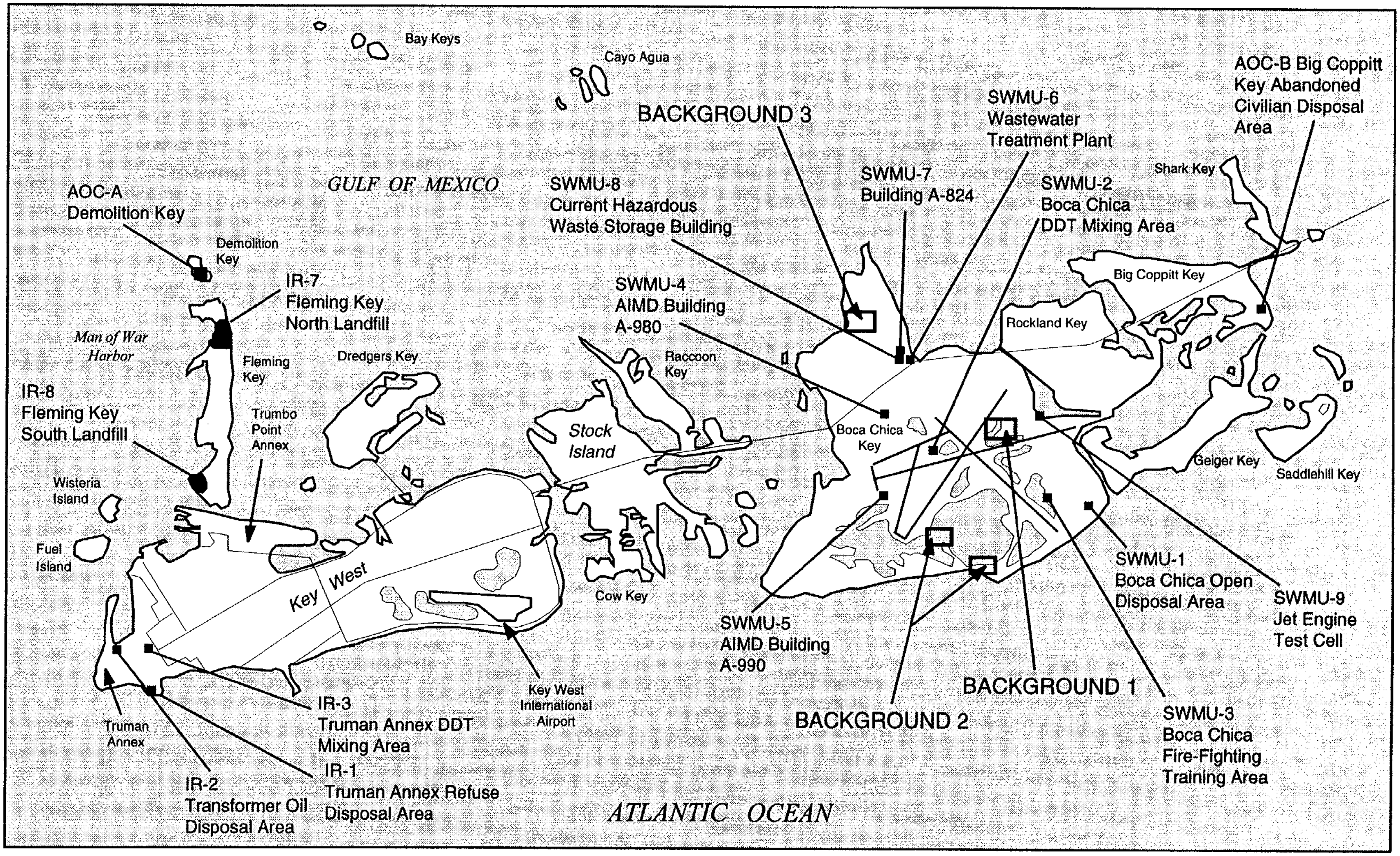
TABLE 1-1

INSTALLATION RESTORATION PROGRAM SITES
NAS KEY WEST

SWMU	Site Name	Known or Suspected Contaminants	Site Status
SWMU 1	Boca Chica Open Disposal Area	Household and construction debris, metal, solvents	Interim cleanup and final investigation completed early 1996
SWMU 2	Boca Chica DDT Mixing Area Building 915	Pesticides	Interim cleanup and final investigation completed early 1996
SWMU 3	Boca Chica Firefighting Training Area	Metals, petroleum	Interim cleanup and final investigation completed 1995-early 1996
SWMU 4	AIMD Building A-908	Metals, solvents	Final investigation planned for 1996-1997
SWMU 5	AIMD Sandblasting Area (by Building A-990)	Metals	Final investigation planned for 1996-1997
SWMU 6	Wastewater Treatment Plant		Further investigation not required due to operating permit status
SWMU 7	Former Hazardous Waste Storage Building A-824	PCBs	Interim cleanup completed 1995
SWMU 8	Current Hazardous Waste Storage Building	Solvents	Further investigation not required due to operating permit status
SWMU 9	Jet Engine Test Cell Building A-969	Petroleum, solvents	Interim groundwater cleanup installed and final investigation completed 1996
IR/AOC	**Site Name**	**Known or Suspected Contaminants**	**Site Status**
IR 1	Truman Annex Refuse Disposal Area	Household and construction debris, metals, solvents	Interim cleanup completed early 1996
IR 2	Transformer Oil Disposal Area	PCBs	Currently proposed for No Further Action and included in Base Realignment and Closure (BRAC) Site Inspection (SI)
IR 3	Truman Annex DDT Mixing Area	Pesticides	Interim cleanup completed 1995
IR 7	Fleming Key North Landfill	Household and construction debris, metals, solvents	Interim cleanup completed 1995
IR 8	Fleming Key South Landfill	Household and construction debris, metals, solvents	Interim measures planned for 1996-1997
AOC A	Demolition Key	Unexploded ordnance, metals	Further investigation and cleanup under CERCLA is suspended pending RCRA closure actions required by FDEP
AOC B	Big Coppitt Key Abandoned Civilian Disposal Area	Discarded motor vehicles, metals	Interim measures completed 1996
	Trumbo Point Bulk Fuel Storage Area	Petroleum	Currently in Contamination Assessment Phase

Source: NAS (1996).

Notes: SWMU = Solid Waste Management Unit.
DDT = Dichlorodiphenyltrichloroethane.
AIMD = Aircraft Intermediate Maintenance Department.
PCB = Polychlorinated biphenyls.
IR = Installation Restoration.
AOC = Area of concern.



Brown & Root Environmental	0 — 1.5 — 3.0 Scale in Miles (Approximate)	FIGURE 1-2. NAS KEY WEST INSTALLATION RESTORATION AND BACKGROUND SITES NAS KEY WEST — KEY WEST, FLORIDA

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TABLE 1-2

STATUS OF INTERIM REMEDIAL ACTIONS
NAS KEY WEST

IR Site	Activity Completed	Notes(1)
SWMU 1	6,275 cubic yards (cy) of soils excavated	Reduced highest lead concentration from 12,300 ppm to 436 ppm
SWMU 2	1,943 cy of DDT-contaminated soil and sediments excavated	Reduced DDT concentration in sediment from 1,400 ppm to 14 ppm
SWMU 3	835 cy of contaminated soil excavated	
SWMU 7	26 cy of PCB-contaminated soil excavated	
IR-1	4,878 cy of soil excavated	Reduced highest lead concentration from 35,200 ppm to 680 ppm
IR-3	735 cy of DDT contaminated	Reduced DDT from 60 to 11 ppm in soil
AOC-B	993 cy of soil excavated	
IR-8	Subcontract awarded to Ocean Breeze Inc. for beach erosion/shoreline protection system (1,800 linear feet)	Construction scheduled January - March 1997
SWMU 9	Groundwater pump and treat system installed July 1996	3 recovery wells with air stripper and oil/water separator and infiltration gallery

1 Of the 15 installation restoration sites at NAS Key West, the above interim remedial actions are the only interim remedial actions completed or planned. Although this report covers only high-priority sites (SWMUs 1, 2, 3, and 9), all interim actions have been shown for completeness.

1.4.2 Project Objectives

Initial RFI/RI field activities were conducted by IT Corporation from January 1992 through April 1992, December 1992 through February 1993, and March 1994 through December 1994. Field activities at NAS Key West included the following tasks:

- Monitoring well installation
- Surface and subsurface soil sample collection
- Surface-water and sediment sample collection
- Groundwater sample collection
- Monitoring well and sample location topographic survey
- Tidal influence studies of selected monitoring wells and piezometers
- Biological inventory of terrestrial and aquatic habitats
- Laboratory analyses of selected Appendix IX groundwater monitoring parameters (40 CFR 264)

In commenting on the initial RFI/RI report, regulatory agencies noted three overlying information deficiencies that necessitated the Supplemental RFI/RI:

- The characterization of the nature and extent of contaminants is incomplete

- Characterization of the ecological risk caused by sites should be based on quantitative ecological sampling and analyses rather than biological inventories and qualitative assessments

- Sitewide background data on chemicals of concern (COCs) should be provided to supplement existing site-specific background data

These areas are the focus of this Supplemental RFI/RI Report. This report includes a complete assessment of the nature and extent of contamination; a human health risk assessment; an ecological risk assessment based on substantial sampling and analyses of biological tissue; and a thorough sitewide background study of Boca Chica Key.

All of the data generated by the studies mentioned above have been used in the risk assessments and other conclusions of this report. Past data were sorted to remove samples from areas excavated as part of the interim removal actions conducted during 1995 and 1996, thus the conclusions of this report are applicable to site conditions as they presently exist.

1.5 REPORT ORGANIZATION

This RFI/RI report has four major chapters and several appendixes. Chapter 1 provides a detailed description of the discovery of installation restoration sites at NAS Key West and the progress of these investigations and cleanups. Chapter 1 also explains the need for and the scope of this Supplemental RFI/RI. Chapter 2 provides an overview of the investigation procedures, data interpretation and presentation methods, and data quality assessment protocols used during the RFI/RI. Sampling locations are shown in Figures 2-2 through 2-17 within Chapter 2. Chapter 3 provides the base environmental setting.

The results of the RFI/RI are presented in Chapter 4, in which SWMUs 1, 2, 3, and 9 are discussed in Sections 4.1, 4.2, 4.3, and 4.4, respectively. Each section contains a description of the nature and extent of contamination, and is followed by the human health risk assessment, the ecological risk assessment, and closes with a discussion of conclusions and recommendations.

The nature and extent subsections of Chapter 4 present the contaminants detected at the site, the spatial and (if applicable) temporal extent to which contaminants have impacted environmental media, and the relationship between the findings and the activities that occurred during base operations. The detected contaminants were compared to applicable or relevant and appropriate requirements (ARARs) and screening action levels (SALs) for each medium (soil, sediment, surface water and groundwater). This approach provides the reader with a quick overview of the distribution and extent of site contaminants that were detected and identifies areas of greatest impact. Figures (i.e., maps of each site) accompany the text to provide the reviewer with a frame of reference regarding site contamination. The approach presented in the text and figures in the "Nature and Extent" sections of the report is a conservative method in which the reader is presented information showing which chemicals most greatly exceed certain standards of protection (i.e., ARARs and SALs). The comparison of measured concentrations to background concentrations was accomplished in the human health and ecological risk assessments, which are presented in each section following a discussion of contaminant fate and transport.

As mentioned above, several appendices are included in the report. While titles of all appendices can be found in the report's table of contents, a brief description of three appendices is in order. Investigation procedures (i.e., methods) are presented in Appendix G (Field Procedures). Within Appendix G, procedures for data quality assessment are presented in Section 2.0, while methods for the human health and ecological risk assessments are presented in Sections 3.2 and 3.3, respectively, of Appendix G. The development and use of the background data set can be found in Appendix J (Background Report for Boca Chica Key). Laboratory analytical reports are included in Appendix L, Volumes 1-3.

2.0 INVESTIGATION PROCEDURES

This chapter contains information regarding the field activities conducted during the Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation (RFI/RI) at the Naval Air Station (NAS) Key West and presents an overview of the methods by which Brown and Root Environmental (B&R Environmental) performed the overall environmental assessments of the sites. Appendix G describes the procedures and protocols that were used.

2.1 OVERVIEW OF SAMPLING CONDUCTED AND INVESTIGATION PROCEDURES

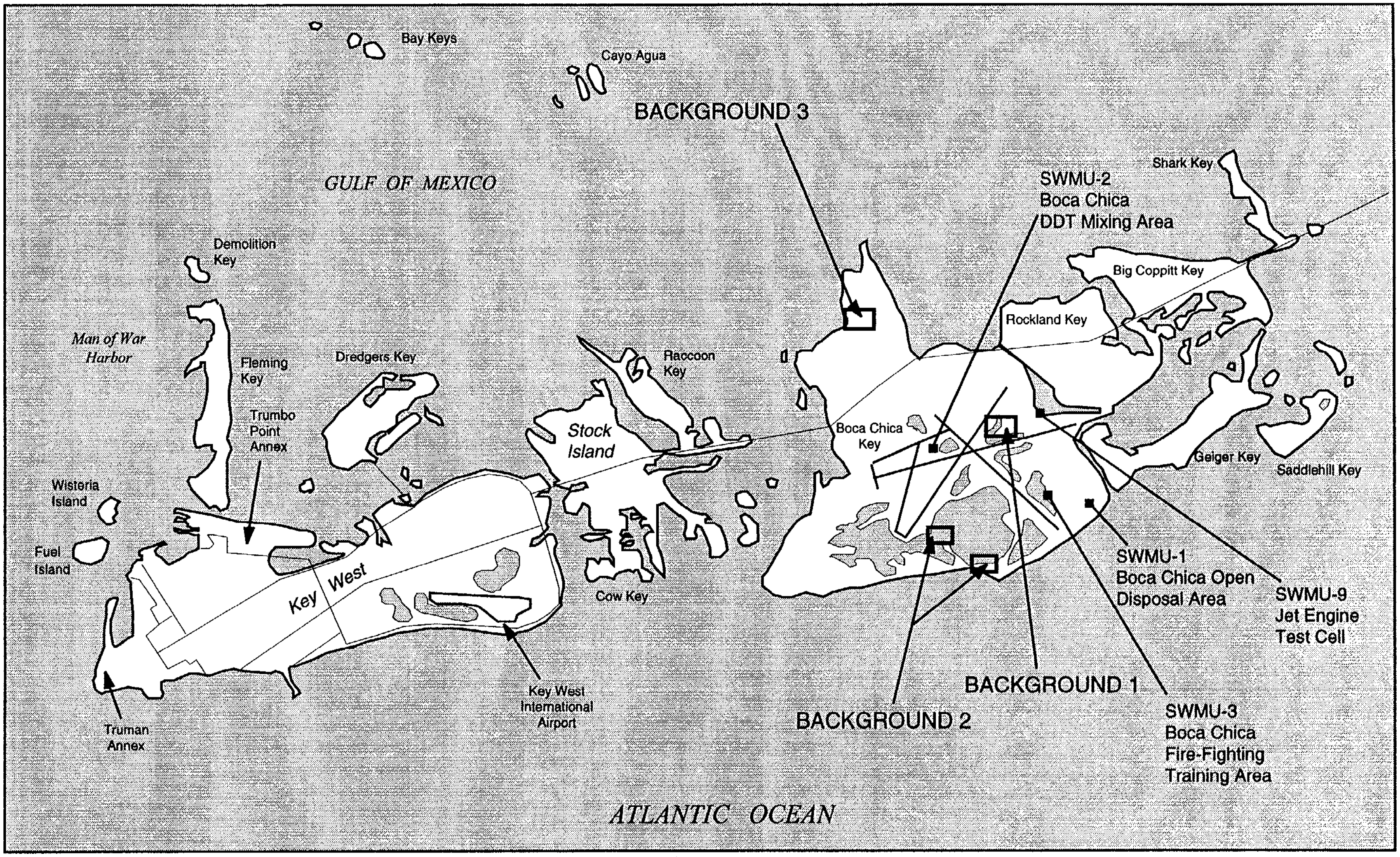
This section presents an overview of the sampling and investigation procedures B&R Environmental used during this first phase of the Supplemental RFI/RI to investigate and report on the four Solid Waste Management Units (SWMUs) with the highest priority. The priorities were determined by the relative risk ranking performed by the Naval Facilities Engineering Command (NAVFACENGCOM)-Southern Division.

2.1.1 Sampling Conducted

In January 1996, B&R Environmental implemented the Supplemental RFI/RI Sampling and Analysis Plan (SAP) in accordance with the regulatory-approved planning documents (ABB, 1995b) at four high-priority SWMUs and three background locations on Boca Chica Key. The RFI/RI included surface soil sampling, subsurface soil sampling, groundwater well installation and sampling, surface-water and sediment sampling, and fish and oyster sampling. Samples were used for chemical and toxicological analyses performed by subcontracted laboratories. In addition, drilling activities were conducted by a subcontractor under B&R Environmental oversight. B&R Environmental personnel conducted land surveys of well and boring installation locations. B&R Environmental subsequently performed a limited validation of the analytical data and organized the data into summary reports.

Figure 2-1 shows the location of the four high priority SWMUs (SWMUs 1, 2, 3, and 9) and the background sites (BG1, BG2, and BG3).

The Supplemental RFI/RI SAP includes the installation of 12 new shallow monitoring wells and 5 soil borings, the collection of surface soil (0 to 1 foot), subsurface soil, sediment, and surface-water samples,



Brown & Root Environmental	0 1.5 3.0 Scale in Miles (Approximate)	FIGURE 2-1. NAS KEY WEST HIGH PRIORITY INSTALLATION RESTORATION SITES NAS KEY WEST — KEY WEST, FLORIDA

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LHO		07/09/97	2
CHECKEY BY:	CONTRACT NO.:	FILE NAME:	
		7046-25PC-Mod0RFI/F2-1Inst.AI	

and the sampling of groundwater from several existing and the 12 newly installed monitoring wells. Table 2-1 summarizes the well installation and environmental sampling programs.

Background conditions were characterized by samples collected and analyzed in previous studies, and by the analyses of samples collected by B&R Environmental during January 1996. The background data set consisted of samples collected from site-specific locations (SWMU 1, SWMU 2, SWMU 3, SWMU 4, and SWMU 7) and from three facility-wide locations chosen to represent Boca Chica Key as a whole (BG 1, BG 2, and BG 3). Groundwater, surface water, sediment, and soil samples were collected and analyzed from the site-specific background locations. At each of the three facility-wide locations, soil, sediment, surface water, and biological samples were collected for chemical analysis, and sediment, surface water, and soil samples were collected for toxicity tests. Biological samples consisted of fish at BG 1, BG 2, and BG 3, and mangrove oysters at BG 3. Appendix J (Background Report for Boca Chica Key) contains details regarding the background data set.

Before biological tissue and soil and water samples were collected for toxicity analyses as part of this Supplemental RFI/RI, no biological samples had been collected as part of the RFI/RI process at NAS Key West. The objective of the current biological field investigations was to characterize the nature and extent of contamination in biota at SWMUs 1, 2, 3, and 9 to assess ecological effects of site-associated contamination. The biological investigation was initiated with a detailed review of existing analytical chemistry data and a review of the results of the preliminary ecological risk evaluation performed by IT Corporation. Following these reviews, a site visit was conducted. Based on the results of this process, the need for additional biological sampling at each site was determined. The RFI/RI (IT Corporation, 1994) recommended toxicity testing and biological tissue analyses of terrestrial and aquatic species for SWMU 1, and toxicity testing and biological tissue analyses of aquatic species for SWMU 2. Because there are minimal vegetation and few ecological receptors at SWMUs 3 and 9, toxicity testing and biological tissue analyses of biota from these sites were not recommended. However, based on comments received from state and Federal regulators during the implementation of the Supplemental RFI/RI, biological tissue analyses were performed at SWMUs 3 and 9.

Table 2-2 lists all samples of soil, water, and sediment collected as a part of this investigation, and the types of analyses performed on each sample. Fish tissue samples were taken from SWMUs 1, 2, 3, and oysters were taken from SWMU 9 following procedures outlined in an Ecological Sampling Technical Memorandum (Appendix B) and are summarized in the fish collection report submitted to the Florida Department of Environmental Protection (FDEP) (Appendix C). Figures 2-2 through 2-17 show the location of all soil, sediment, surface-water, groundwater, fish and oyster samples obtained.

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2.1.2 Investigation Procedures

Field investigation and risk assessment procedures are contained in the Supplemental RFI/RI workplan (ABB, 1995a), which was prepared in response to regulatory concerns over data gaps in the initial RFI/RI report (IT Corporation, 1994). The ABB Environmental Services, Inc., (AAB) workplan refers to procedures contained in the RFI/RI workplan prepared by IT Corporation (IT Corporation, 1993) for the initial (Phase I) RFI/RI investigation. In some instances, the ABB workplan and the IT workplan presented

TABLE 2-1

WELL INSTALLATION AND ENVIRONMENTAL SAMPLING PROGRAMS
SUPPLEMENTAL RFI/RI
NAS KEY WEST

Site	Monitoring Well Installation (number of wells/average depth in feet)	Groundwater Sampling (number of samples)	Soil Sampling [number of samples at common location for surface (SS) and subsurface (SB)]	Sediment Sampling (number of samples and locations)	Surface-Water Sampling (number of samples and locations)
SWMU 1: Boca Chica Open Disposal Area	4/12	4	3-SS	6	6
SWMU 2: Boca Chica DDT Mixing Area	4/12	6	5-SS	4	4
SWMU 3: Boca Chica Fire-Fighting Training Area	4/12	6		5	5
SWMU 9: Jet Test Cell Building	0/12	8	5-SS 5-SB	5	5
Facility-Wide Background			9-SS	3	3
Facility-Wide Background (AOCs)			5-SS	5	5
Totals	**12**	**24**	**5-SB 27 SS**	**28**	**28**

Source: ABB (1995a).

Notes: SWMU = Solid Waste Management Unit.
DDT = Dichlorodiphenyltrichloroethane.
AOC = Area of Concern.

TABLE 2-2

SUMMARY OF NAS KEY WEST SAMPLE ANALYSES
NAS KEY WEST
PAGE 1 OF 4

Sample ID	Type	Date	APP. IX VOC	APP. IX SVOC	Pest./PCBs	Herb	TAL Metals	Cyanide	Toxicity	Duplicate Sample
SWMU 1										
S1MW-4	Water	1/30/96	X	X	X	X	X	X		
S1MW-5	Water	1/30/96	X	X	X	X	X	X		
S1MW-6	Water	1/30/96	X	X	X	X	X	X		
S1SD-01	Soil	1/22/96	X	X	X	X	X	X	1	
S1SD-02	Soil	1/22/96	X	X	X	X	X	X	1	
S1SD-03	Soil	1/24/96	X	X	X	X	X	X	1	
S1SD-04	Soil	1/24/96							1	
S1SD-05	Soil	1/24/96							1	
S1SS-5	Soil	1/13/96	X	X	X	X	X	X	5 (1/31/96)	
S1DPSS-1	Soil	1/13/96	X	X	X	X	X	X		S1SS-5
S1SS-6	Soil	1/13/96	X	X	X	X	X	X		
S1SS-7	Soil	1/13/96	X	X	X	X	X	X	5 (1/31/96)	
S1SW-01	Water	1/22/96							2	
S1SW-02	Water	1/22/96							2	
S1SW-03	Water	1/24/96							2	
S1SW-04	Water	1/24/96							2	
S1SW-05	Water	1/24/96							2	
SWMU 2										
S2MW-5	Water	1/28/96			X	X	X	X		
S2MW-6	Water	1/28/96			X	X	X	X		
S2MW-7	Water	1/28/96			X	X	X	X		
MW5-1	Water	1/28/96			X	X	X	X		
S2SD-01	Soil	1/24/96							3	
S2SD-02	Soil	1/25/96							3	
S2SD-03	Soil	1/25/96							3	
S2SD-04	Soil	1/25/96							3	
S2SD-05	Soil	1/24/96							3	
S2SW-01	Water	1/24/96							4	
S2SW-02	Water	1/25/96							4	
S2SW-03	Water	1/25/96							4	
S2SW-04	Water	1/25/96							4	
S2SW-05	Water	1/24/96							4	

TABLE 2-2

SUMMARY OF NAS KEY WEST SAMPLE ANALYSES
NAS KEY WEST
PAGE 2 OF 4

Sample ID	Type	Date	APP. IX VOC	APP. IX SVOC	Pest./PCBs	Herb	TAL Metals	Cyanide	Toxicity	Duplicate Sample
SWMU 3										
S3MW-1	Water	2/1/96	X	X						
S3MW-2	Water	2/1/96	X	X						
S3MW-6	Water	1/31/96	X	X						
S3MW-7	Water	2/1/96	X	X						
S3DPGW-01	Water	2/1/96	X	X						S3MW-7
S3MW-8	Water	2/1/96	X	X						
S3MW-9	Water	2/1/96	X	X						
S3SD-01	Soil	1/25/96					X	X	3	
S3SD-02	Soil	1/25/96					X	X	3	
S3DPSD-01	Soil	1/25/96					X	X		S3SD-02
S3SD-03	Soil	1/25/96					X	X	3	
S3SD-04	Soil	1/25/96					X	X	3	
S3SD-O5	Soil	1/25/96					X	X	3	
S3SW-01	Water	1/25/96					X	X	4	
S3DPSW-O1	Water	1/25/96					X	X		S3SW-01
S3SW-02	Water	1/25/96					X	X	4	
S3SW-03	Water	1/25/96					X	X	4	
S3SW-04	Water	1/25/96					X	X	4	
S3SW-05	Water	1/25/96					X	X	4	
SWMU 9										
S9MW-3	Water	1/18/96	X	X	X	X	X	X		
S9MW-6	Water	1/18/96	X	X	X	X	X	X		
S9MW-9	Water	1/18/96	X	X	X	X	X	X		
S9MW-15	Water	1/18/96	X	X	X	X	X	X		
S9MW-17	Water	1/18/96	X	X	X	X	X	X		
S9DPGW-01	Water	1/18/96	X	X	X	X	X	X		S9MW-17
S9MW-19D	Water	1/19/96	X	X	X	X	X	X		
S9MW-21	Water	1/18/96	X	X	X	X	X	X		
S9MW-24	Water	1/19/96	X	X	X	X	X	X		
S9SB-1	Soil	1/17/96	X	X	X	X	X	X		
S9DPSB-01	Soil	1/17/96	X	X	X	X	X	X		S9SB-1
S9SB-2	Soil	1/17/96	X	X	X	X	X	X		
S9SB-3	Soil	1/17/96	X	X	X	X	X	X		
S9SB-4	Soil	1/17/96	X	X	X	X	X	X		

TABLE 2-2

SUMMARY OF NAS KEY WEST SAMPLE ANALYSES
NAS KEY WEST
PAGE 3 OF 4

Sample ID	Type	Date	APP. IX VOC	APP. IX SVOC	Pest./PCBs	Herb	TAL Metals	Cyanide	Toxicity	Duplicate Sample
SWMU 9 (cont.)										
S9SB-5	Soil	1/17/96	X	X	X	X	X	X		
S9SD-01	Soil	1/23/96	X	X	X	X	X	X	1	
S9SD-02	Soil	1/23/96	X	X	X	X	X	X	1	
S9SD-03	Soil	1/23/96	X	X	X	X	X	X	1	
S9SD-04	Soil	1/23/96	X	X	X	X	X	X	1	
S9SD-05	Soil	1/23/96	X	X	X	X	X	X	1	
S9SS-1	Soil	1/15/96	X	X	X	X	X	X		
S9SS-2	Soil	1/15/96	X	X	X	X	X	X		
S9SS-3	Soil	1/15/96	X	X	X	X	X	X		
S9DPSS-1	Soil	1/15/96	X	X	X	X	X	X		S9SS-3
S9SS-4	Soil	1/15/96	X	X	X	X	X	X		
S9SS-5	Soil	1/15/96	X	X	X	X	X	X		
S9SW-01	Water	1/23/96	X	X	X	X	X	X	2	
S9SW-02	Water	1/23/96	X	X	X	X	X	X	2	
S9SW-03	Water	1/23/96	X	X	X	X	X	X	2	
S9DPSW-01	Water	1/23/96	X	X	X	X	X	X		S9SW-03
S9SW-04	Water	1/23/96	X	X	X	X	X	X	2	
S9SW-05	Water	1/23/96	X	X	X	X	X	X	2	
BACKGROUND SAMPLES										
S1MW-3	Water	1/30/96	X	X	X	X	X	X		
S1DPGW-01	Water	1/30/96	X	X	X	X	X	X		S1MW-3
S1SS-4	Soil	1/13/96	X	X	X	X	X	X	5 (1/31/96)	
S2MW-1	Water	1/28/96			X	X	X	X		
S2DPGW-01	Water	1/28/96			X	X	X	X		S2MW-1
S2MW-4	Water	1/28/96			X	X	X	X		
BG1SD-01	Soil	1/26/96	X	X	X	X	X	X	3	
BG1SS-01	Soil	1/26/96	X	X	X	X	X	X	5	
BG1SS-02	Soil	2/2/96	X	X	X	X	X	X		
BG1SS-03	Soil	2/2/96	X	X	X	X	X	X		
BG1SW-01	Water	1/26/96	X	X	X	X	X	X	4	
BG2SD-01	Soil	1/26/96	X	X	X	X	X	X	1	
BG2SS-01	Soil	1/26/96	X	X	X	X	X	X	5	
BG2SS-02	Soil	1/31/96	X	X	X	X	X	X		
BG2SS-03	Soil	1/31/96	X	X	X	X	X	X		

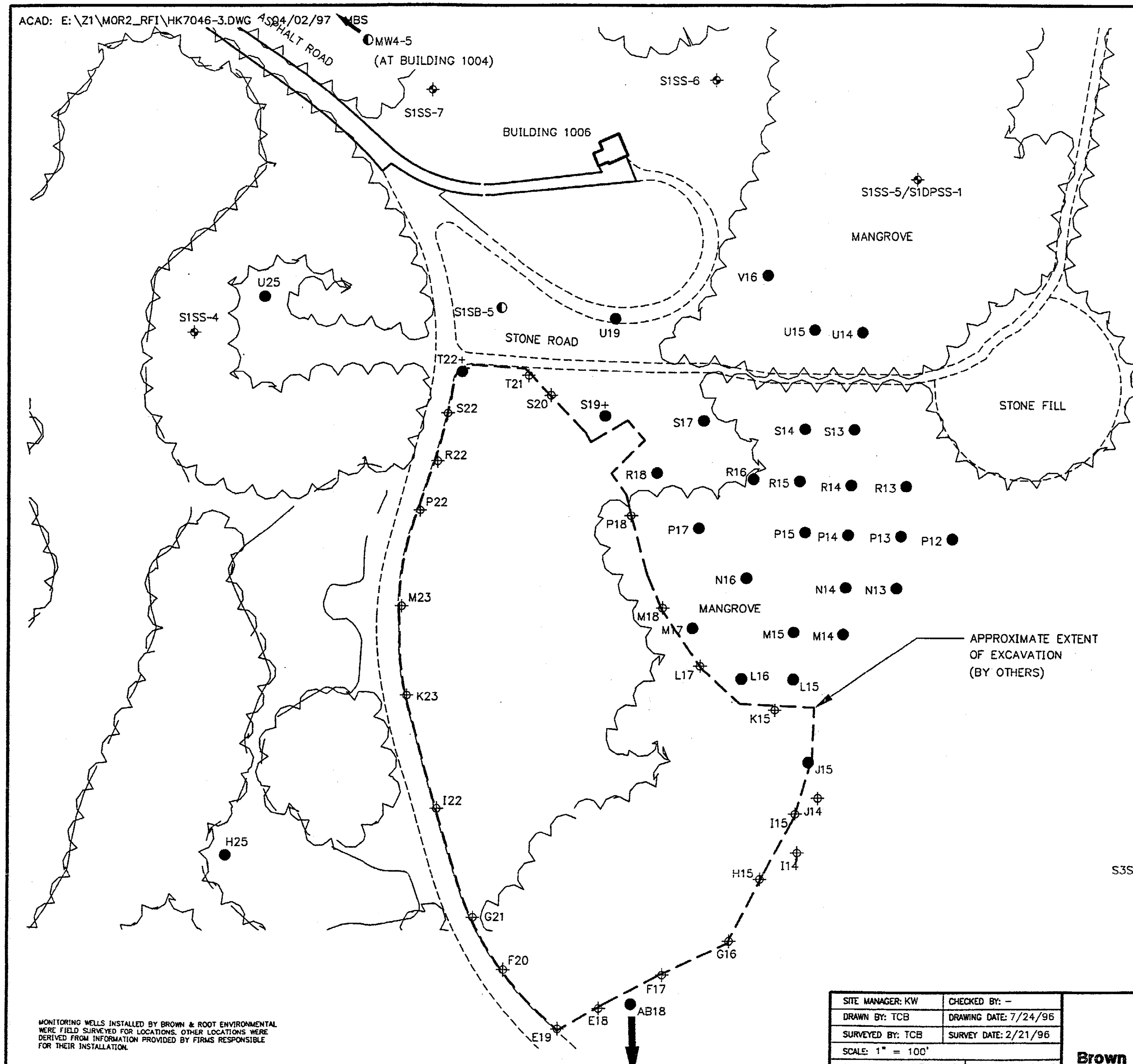
TABLE 2-2

SUMMARY OF NAS KEY WEST SAMPLE ANALYSES
NAS KEY WEST

Sample ID	Type	Date	APP. IX VOC	APP. IX SVOC	Pest./PCBs	Herb	TAL Metals	Cyanide	Toxicity	Duplicate Sample
BACKGROUND SAMPLES (cont.)										
BG2SW-01	Water	1/26/96	X	X	X	X	X	X	2	
BG3SD-01	Soil	1/26/96	X	X	X	X	X	X	1	
BG3SS-01	Soil	1/26/96	X	X	X	X	X	X	5	
BG3SS-02	Soil	2/2/96	X	X	X	X	X	X		
BG3SS-03	Soil	2/2/96	X	X	X	X	X	X		
BG3SW-01	Water	1/26/96	X	X	X	X	X	X	2	
BLANK SAMPLES										
FB01-011696	Water	1/16/96	X	X	X	X	X	X		
FB02-011696	Water	1/16/96	X	X	X	X	X	X		
FB03-013196	Water	1/31/96	X	X	X	X	X	X		
RB01-011596	Water	1/15/96	X	X	X	X	X	X		
RB01-011796	Water	1/17/96	X	X	X	X	X	X		
RB01-012296	Water	1/22/96	X	X	X	X	X	X		
RB01-012496	Water	1/24/96	X	X	X	X	X	X		
RB01-020296	Water	2/2/96	X	X	X	X	X	X		
TB01-011396	Water	1/13/96	X							
TB01-011596	Water	1/15/96	X							
TB01-011696	Water	1/16/96	X							
TB01-011796	Water	1/17/96	X							
TB01-011896	Water	1/18/96	X							
TB02-011896	Water	1/18/96	X							
TB01-011996	Water	1/19/96	X							
TB01-012296	Water	1/22/96	X							
TB01-012396	Water	1/23/96	X							
TB01-012496	Water	1/24/96	X							
TB02-012496	Water	1/24/96	X							
TB01-012696	Water	1/26/96	X							
TB01-013096	Water	1/30/96	X							
TB01-013196	Water	1/31/96	X							
TB01-020296	Water	2/2/96	X							

Toxicity Analyses:
1 Mysid shrimp
2 Siverside, oyster, and sea urchin
3 Amphipod
4 Silverside
5 Earthworm

ACAD: E:\Z1\MOR2_RFI\HK7046-3.DWG 04/02/97 MBS



MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

N

50 25 0 100

Scale 1" = 100'

NOTE: S1SS-4 AND U25 WERE BACKGROUND SAMPLE LOCATIONS. S1SS-4 WAS USED FOR BOTH EARTHWORM TOXICITY TESTS AND CHEMICAL ANALYSIS.

NOTE: S1SS-5 AND S1SS-4 WERE USED FOR BOTH EARTHWORM TOXICITY TESTS AND CHEMICAL ANALYSIS.

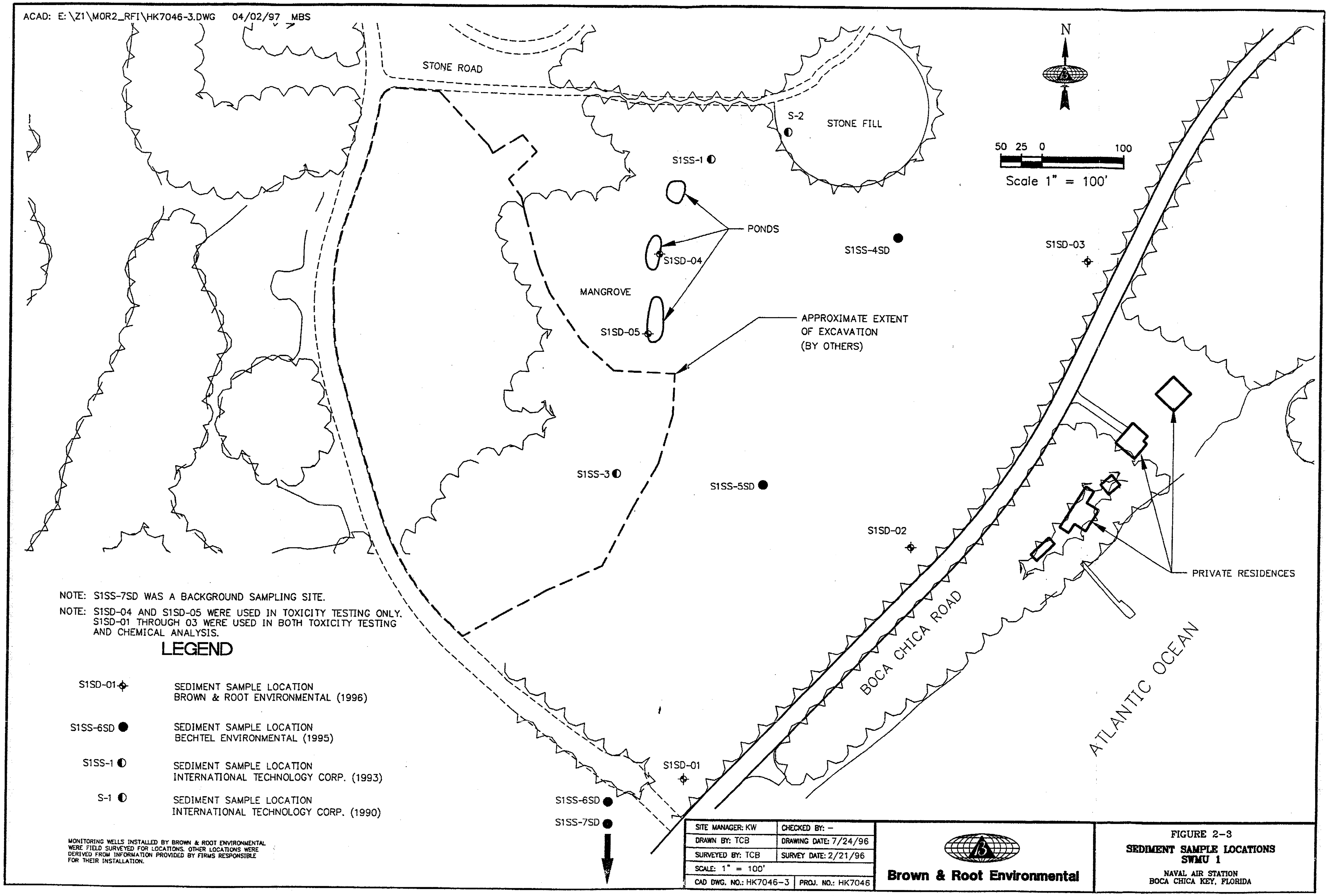
LEGEND

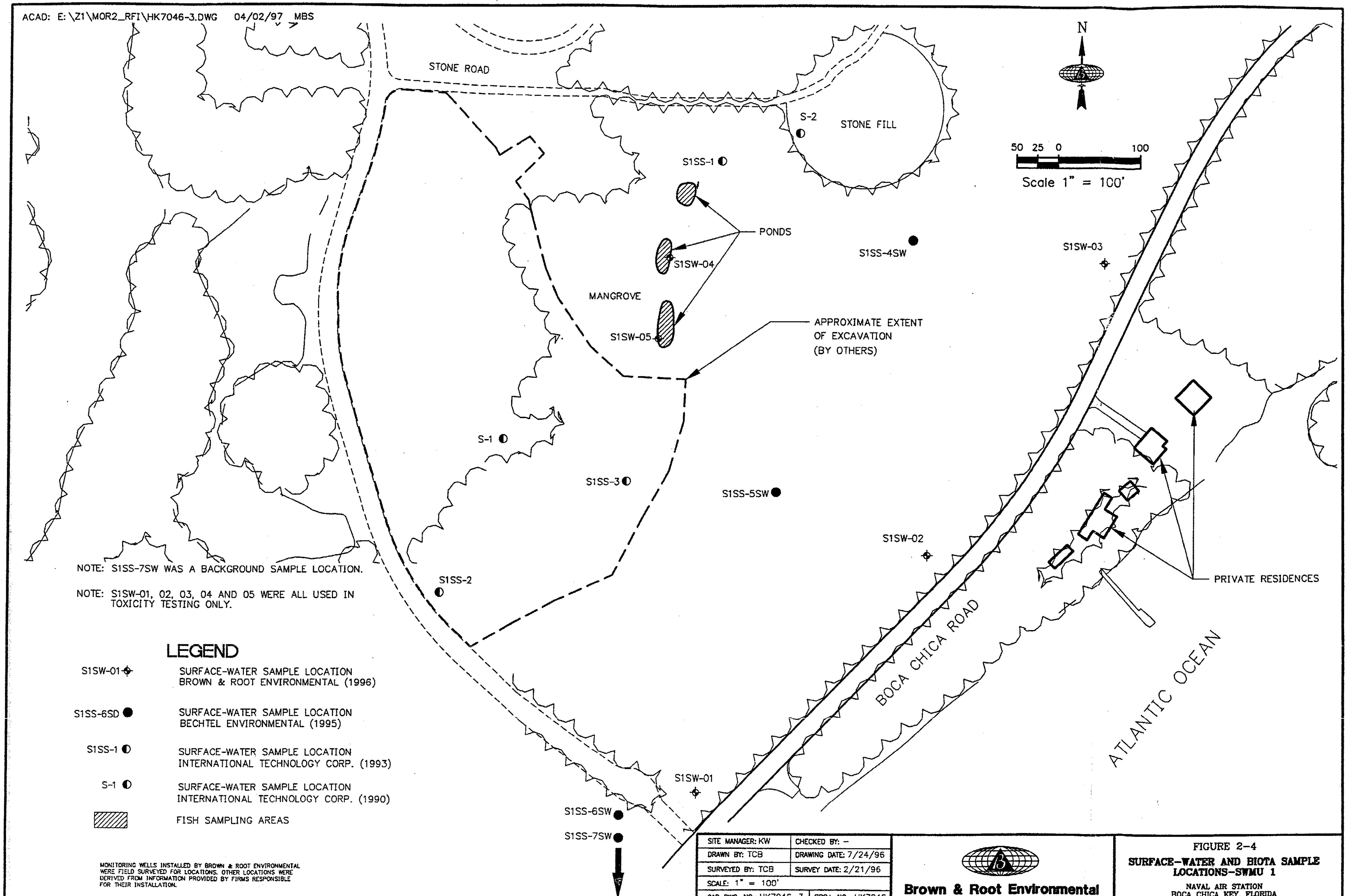
S1SS-7	SOIL BORING/SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
P15	SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
J14	SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
S3SB/SS-1	SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
MW4-5	SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
+	ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996

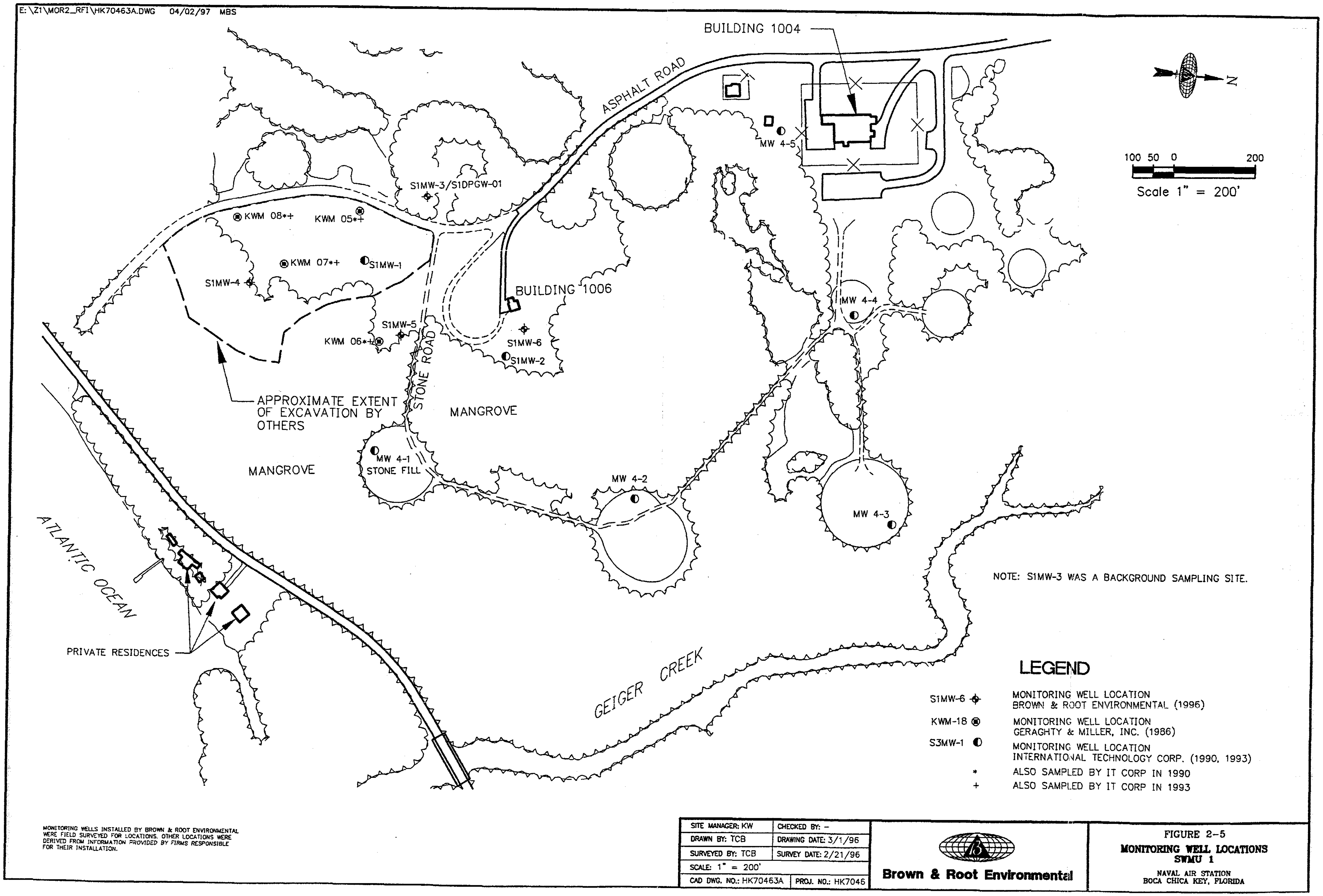
SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-3	PROJ. NO.: HK7046

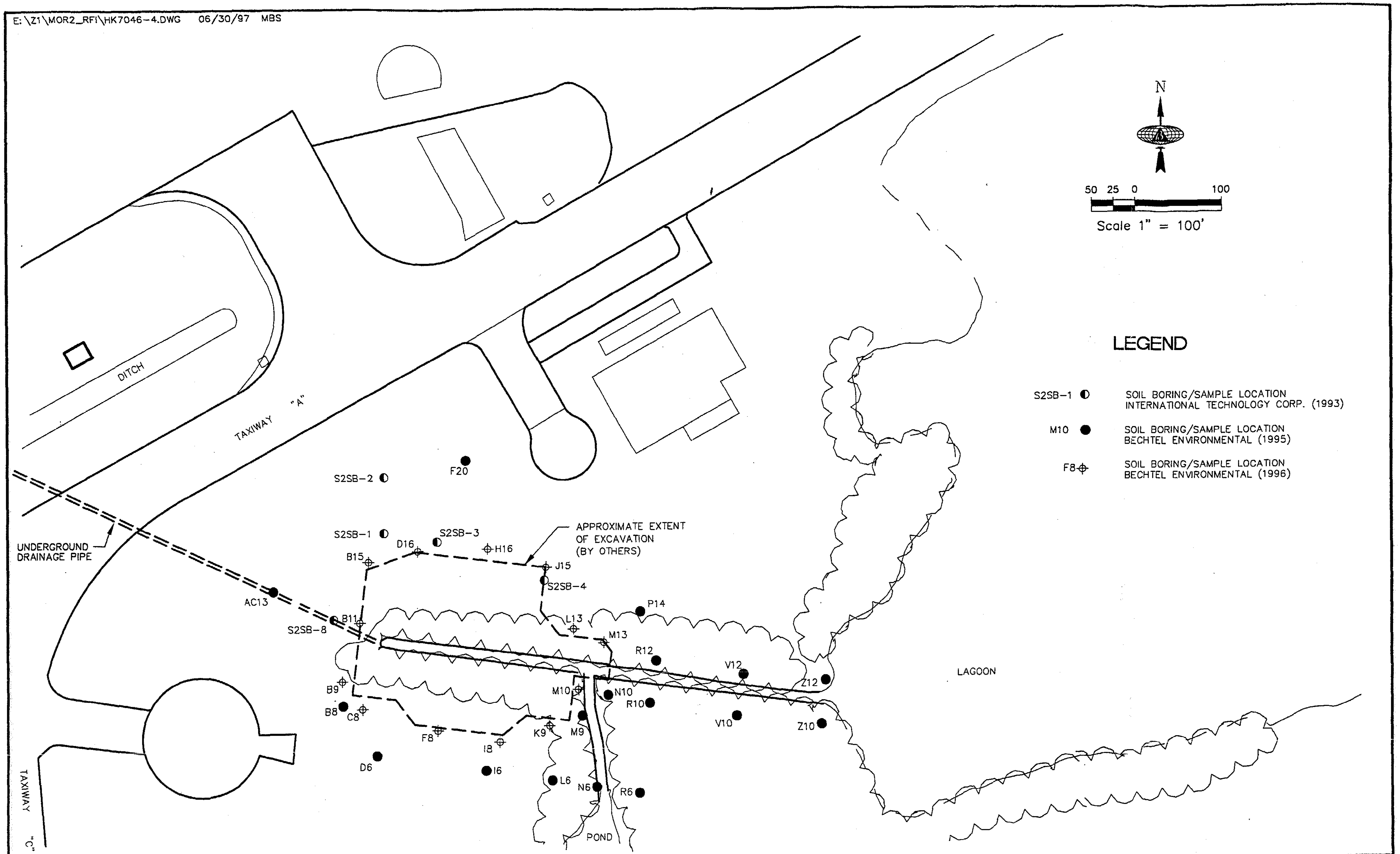
Brown & Root Environmental

FIGURE 2-2
SOIL BORING/SAMPLE LOCATIONS
SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


ACAD: E:\Z1\MOR2_RFI\HK7046-3.DWG 04/02/97 MBS
N
50 25 0 100
Scale 1" = 100'
STONE ROAD
S-2
STONE FILL
S1SS-1
PONDS
S1SS-4SD
S1SD-03
S1SD-04
MANGROVE
APPROXIMATE EXTENT
OF EXCAVATION
(BY OTHERS)
S1SD-05
S1SS-3
S1SS-5SD
S1SD-02
PRIVATE RESIDENCES
BOCA CHICA ROAD
ATLANTIC OCEAN
S1SD-01
S1SS-6SD
S1SS-7SD
NOTE: S1SS-7SD WAS A BACKGROUND SAMPLING SITE.
NOTE: S1SD-04 AND S1SD-05 WERE USED IN TOXICITY TESTING ONLY. S1SD-01 THROUGH 03 WERE USED IN BOTH TOXICITY TESTING AND CHEMICAL ANALYSIS.
LEGEND
S1SD-01 SEDIMENT SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S1SS-6SD SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
S1SS-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
S-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: –
DRAWN BY: TCB
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-3
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-3
SEDIMENT SAMPLE LOCATIONS
SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


ACAD: E:\Z1\MOR2_RFI\HK7046-3.DWG 04/02/97 MBS
STONE ROAD
STONE FILL
S-2
S1SS-1
PONDS
S1SS-4SW
S1SW-04
MANGROVE
S1SW-05
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
S1SW-03
S-1
S1SS-3
S1SS-5SW
S1SW-02
S1SS-2
PRIVATE RESIDENCES
BOCA CHICA ROAD
ATLANTIC OCEAN
S1SW-01
S1SS-6SW
S1SS-7SW
N
50 25 0 100
Scale 1" = 100'
NOTE: S1SS-7SW WAS A BACKGROUND SAMPLE LOCATION.
NOTE: S1SW-01, 02, 03, 04 AND 05 WERE ALL USED IN TOXICITY TESTING ONLY.
LEGEND
S1SW-01 SURFACE-WATER SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S1SS-6SD SURFACE-WATER SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
S1SS-1 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
S-1 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
FISH SAMPLING AREAS
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: –
DRAWN BY: TCB
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-3
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-4
SURFACE-WATER AND BIOTA SAMPLE LOCATIONS-SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


E:\Z1\MOR2_RFI\HK70463A.DWG 04/02/97 MBS
BUILDING 1004
ASPHALT ROAD
MW 4-5
100 50 0 200
Scale 1" = 200'
S1MW-3/S1DPGW-01
KWM 08*+
KWM 05*+
KWM 07*+
S1MW-1
S1MW-4
BUILDING 1006
S1MW-5
KWM 06*+
S1MW-6
S1MW-2
MW 4-4
STONE ROAD
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
MANGROVE
MW 4-1 STONE FILL
MANGROVE
MW 4-2
MW 4-3
ATLANTIC OCEAN
NOTE: S1MW-3 WAS A BACKGROUND SAMPLING SITE.
PRIVATE RESIDENCES
GEIGER CREEK
LEGEND
S1MW-6 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
KWM-18 MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)
S3MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
* ALSO SAMPLED BY IT CORP IN 1990
+ ALSO SAMPLED BY IT CORP IN 1993
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB
DRAWING DATE: 3/1/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 200'
CAD DWG. NO.: HK70463A
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-5
MONITORING WELL LOCATIONS
SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

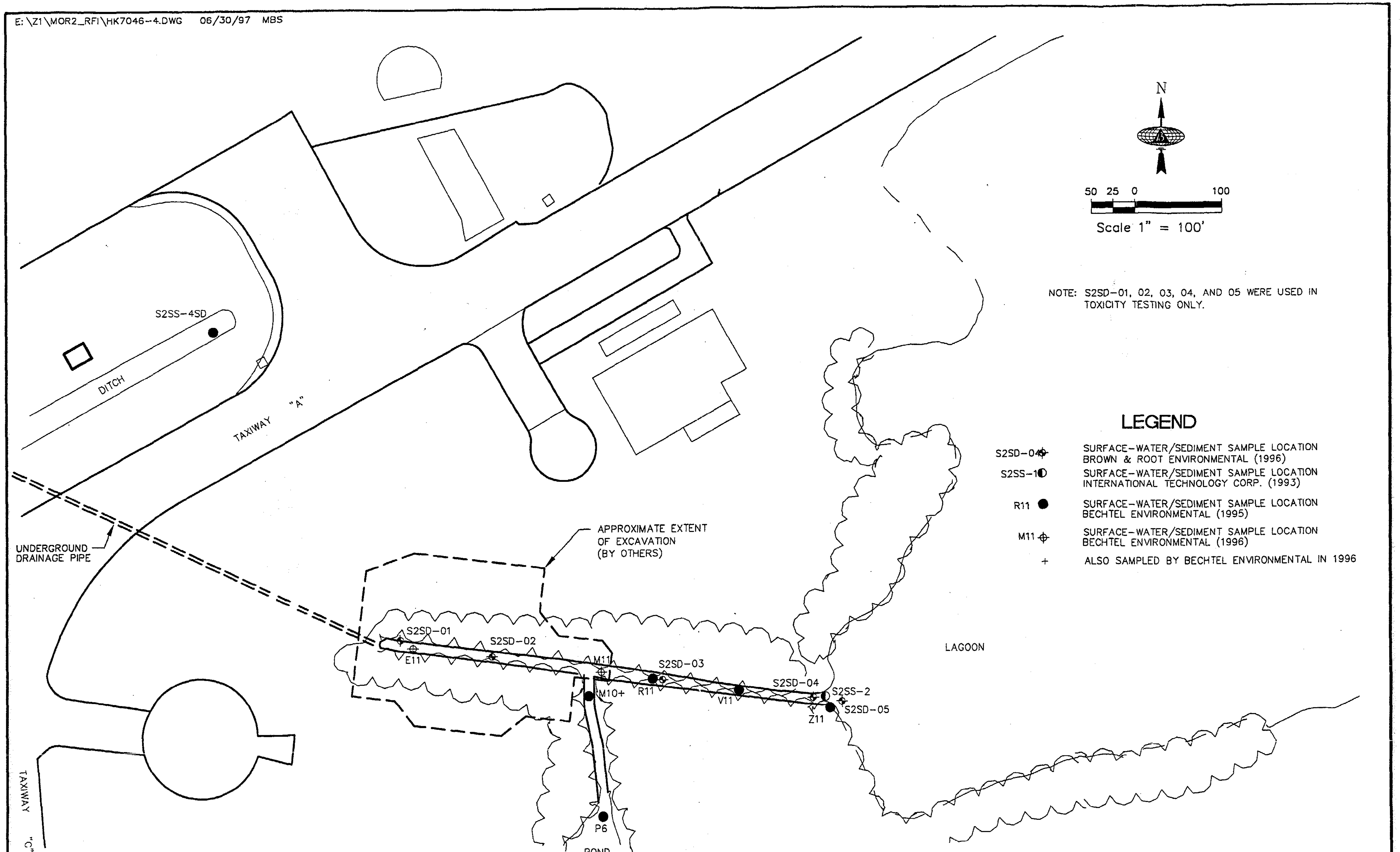


MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-6
SOIL BORING/SAMPLE LOCATIONS SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



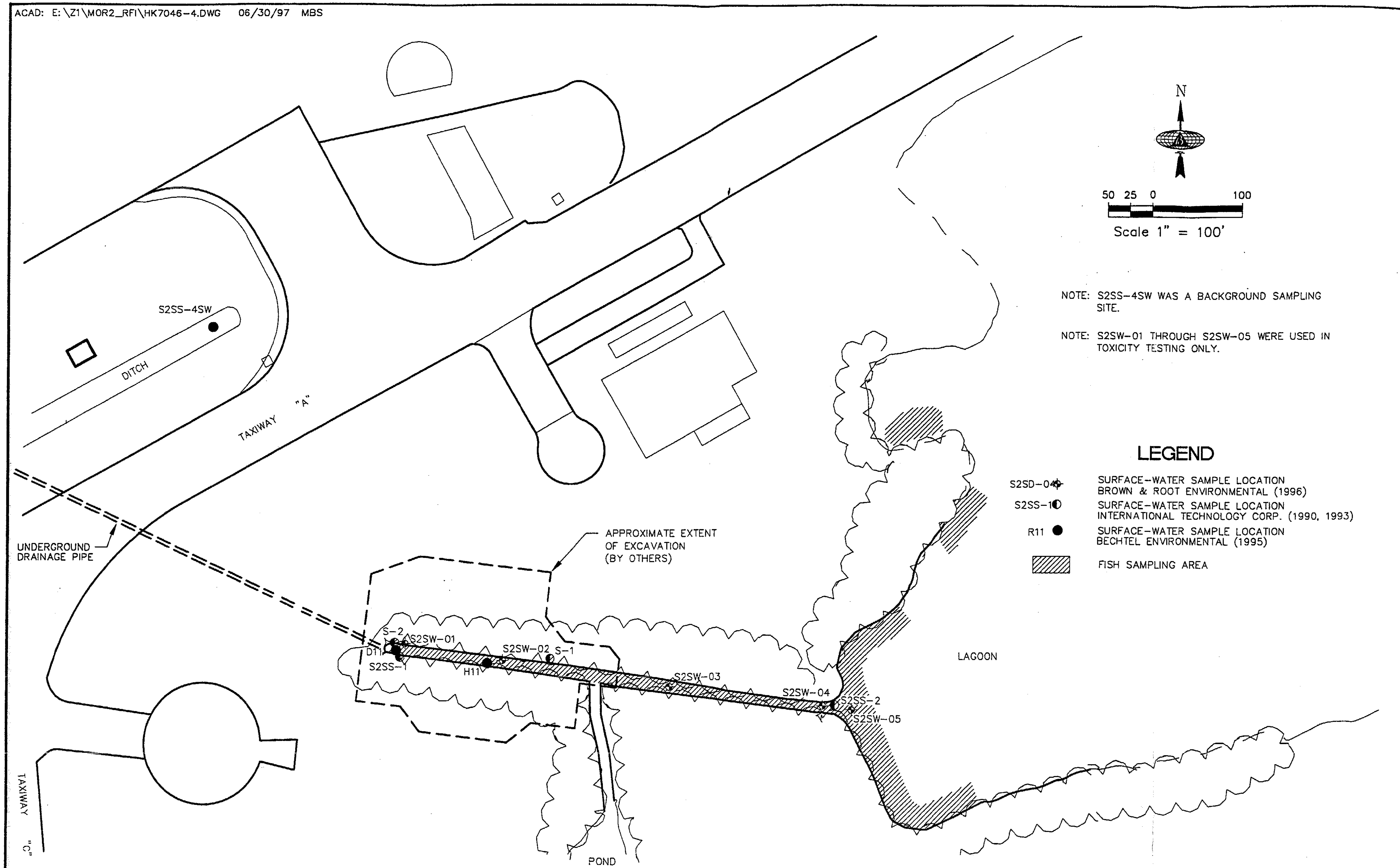
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-7
SEDIMENT SAMPLE LOCATIONS
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

ACAD: E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS

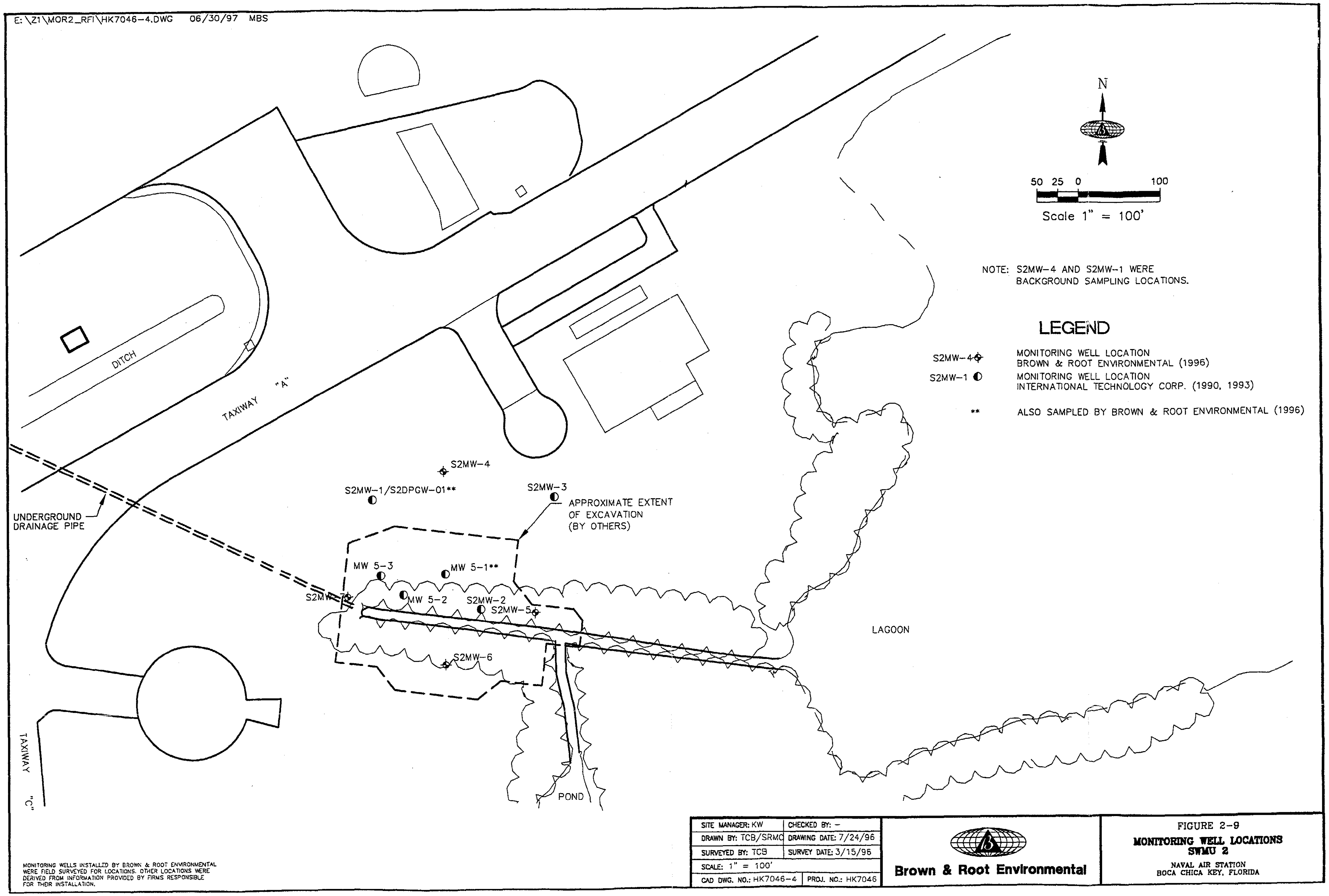


MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

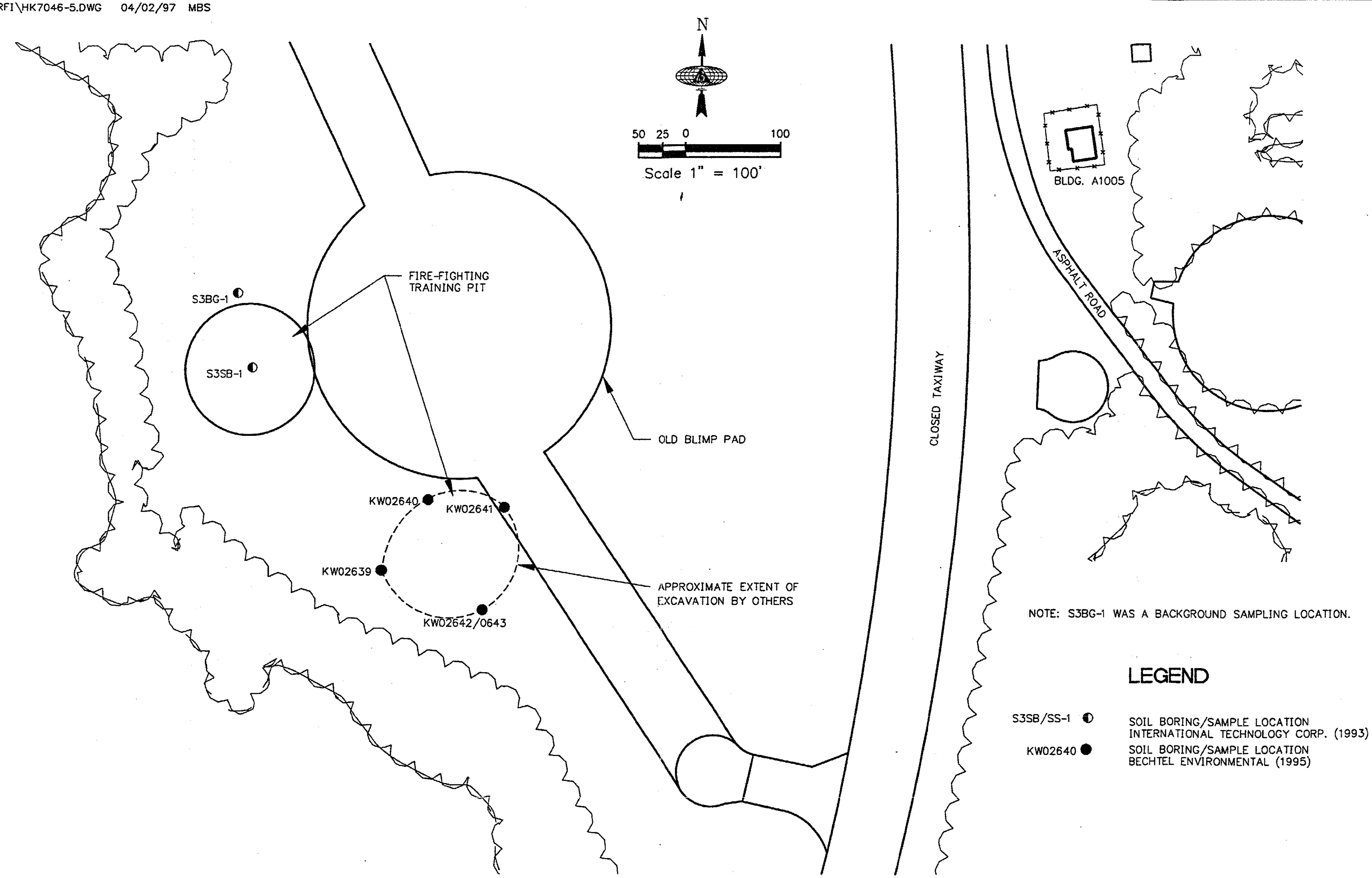
SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-8
SURFACE-WATER AND BIOTA SAMPLE LOCATIONS-SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS
N
50 25 0 100
Scale 1" = 100'
NOTE: S2MW-4 AND S2MW-1 WERE BACKGROUND SAMPLING LOCATIONS.
LEGEND
S2MW-4 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S2MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
** ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)
DITCH
TAXIWAY "A"
S2MW-4
S2MW-1/S2DPGW-01**
S2MW-3
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
UNDERGROUND DRAINAGE PIPE
MW 5-3
MW 5-1**
S2MW-7
MW 5-2
S2MW-2
S2MW-5
S2MW-6
LAGOON
POND
TAXIWAY "C"
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: –
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-4
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-9
MONITORING WELL LOCATIONS
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

E:\Z1\MOR2_RFI\HK7046-5.DWG 04/02/97 MBS



NOTE: S3BG-1 WAS A BACKGROUND SAMPLING LOCATION.

LEGEND

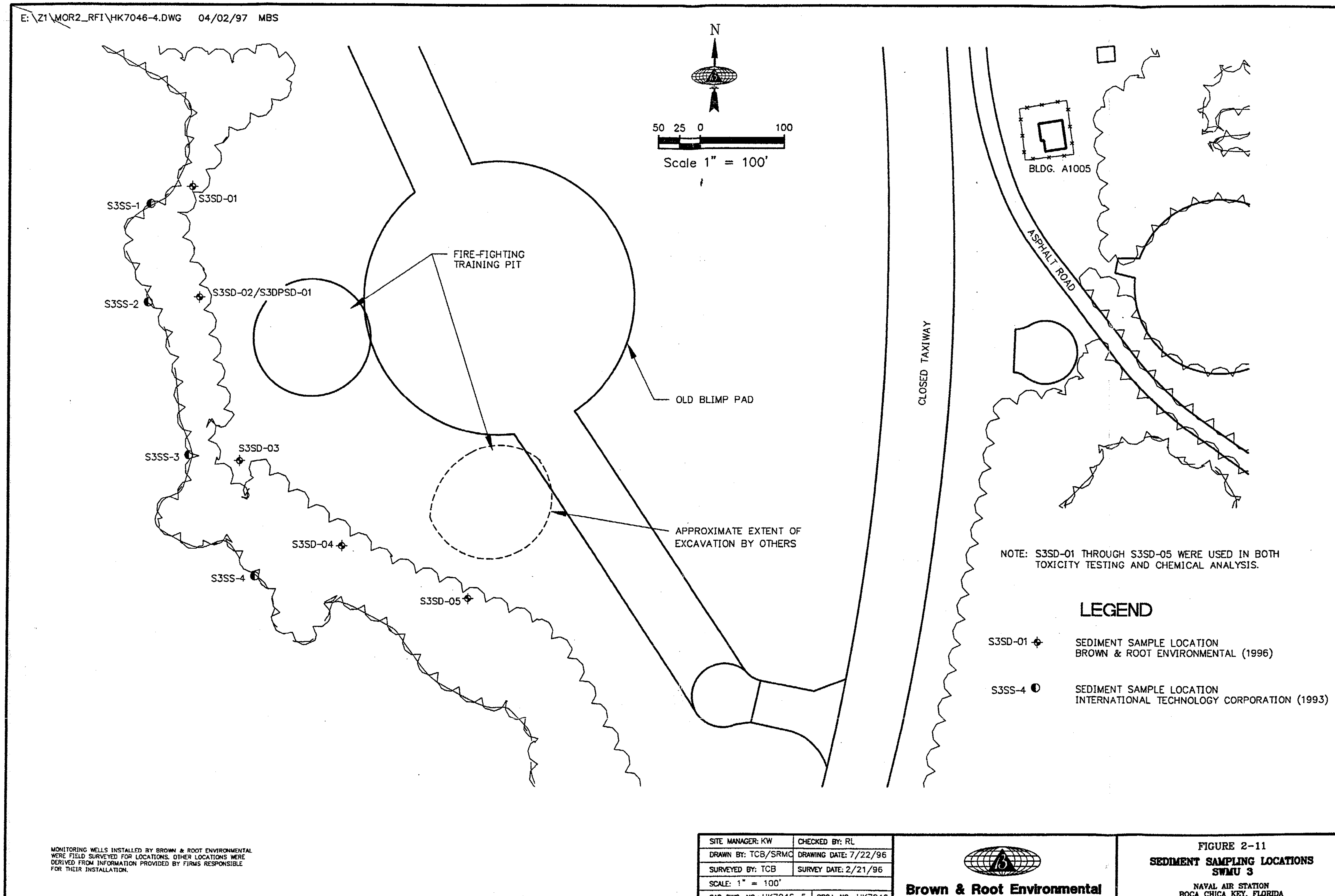
S3SB/SS-1 ◐	SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
KW02640 ●	SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)

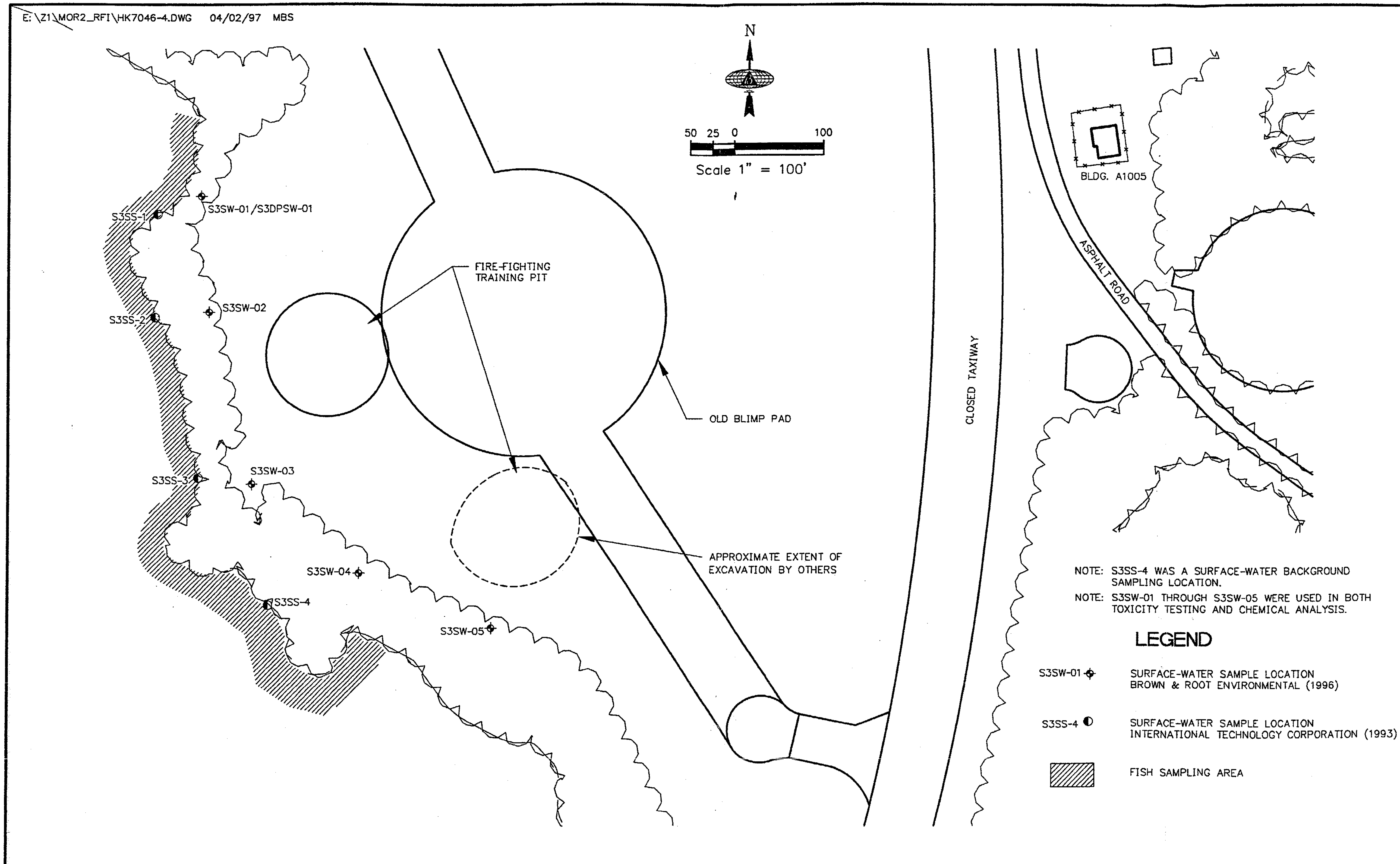
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: RL
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/22/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-10
SOIL BORING LOCATIONS SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


E:\Z1\MOR2_RFI\HK7046-4.DWG 04/02/97 MBS
N
50 25 0 100
Scale 1" = 100'
S3SS-1
S3SD-01
S3SD-02/S3DPSD-01
S3SS-2
FIRE-FIGHTING TRAINING PIT
OLD BLIMP PAD
CLOSED TAXIWAY
BLDG. A1005
ASPHALT ROAD
S3SS-3
S3SD-03
S3SD-04
S3SS-4
S3SD-05
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
NOTE: S3SD-01 THROUGH S3SD-05 WERE USED IN BOTH TOXICITY TESTING AND CHEMICAL ANALYSIS.
LEGEND
S3SD-01 SEDIMENT SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S3SS-4 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORPORATION (1993)
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: RL
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/22/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-5
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-11
SEDIMENT SAMPLING LOCATIONS
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA



SITE MANAGER: KW	CHECKED BY: RL
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/22/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-12
SURFACE-WATER AND BIOTA SAMPLING LOCATIONS-SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

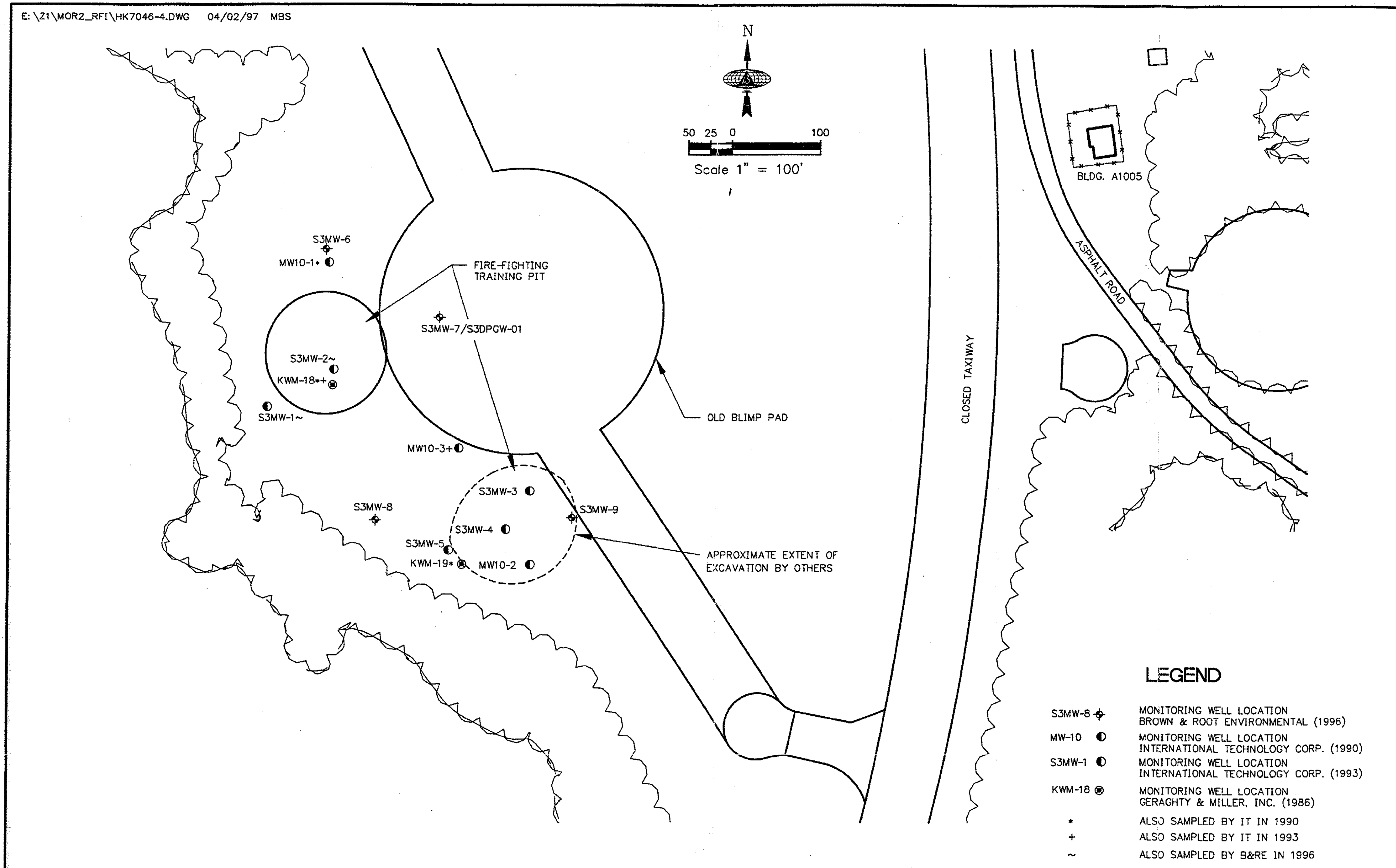


FIGURE 2-13
MONITORING WELL LOCATIONS
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

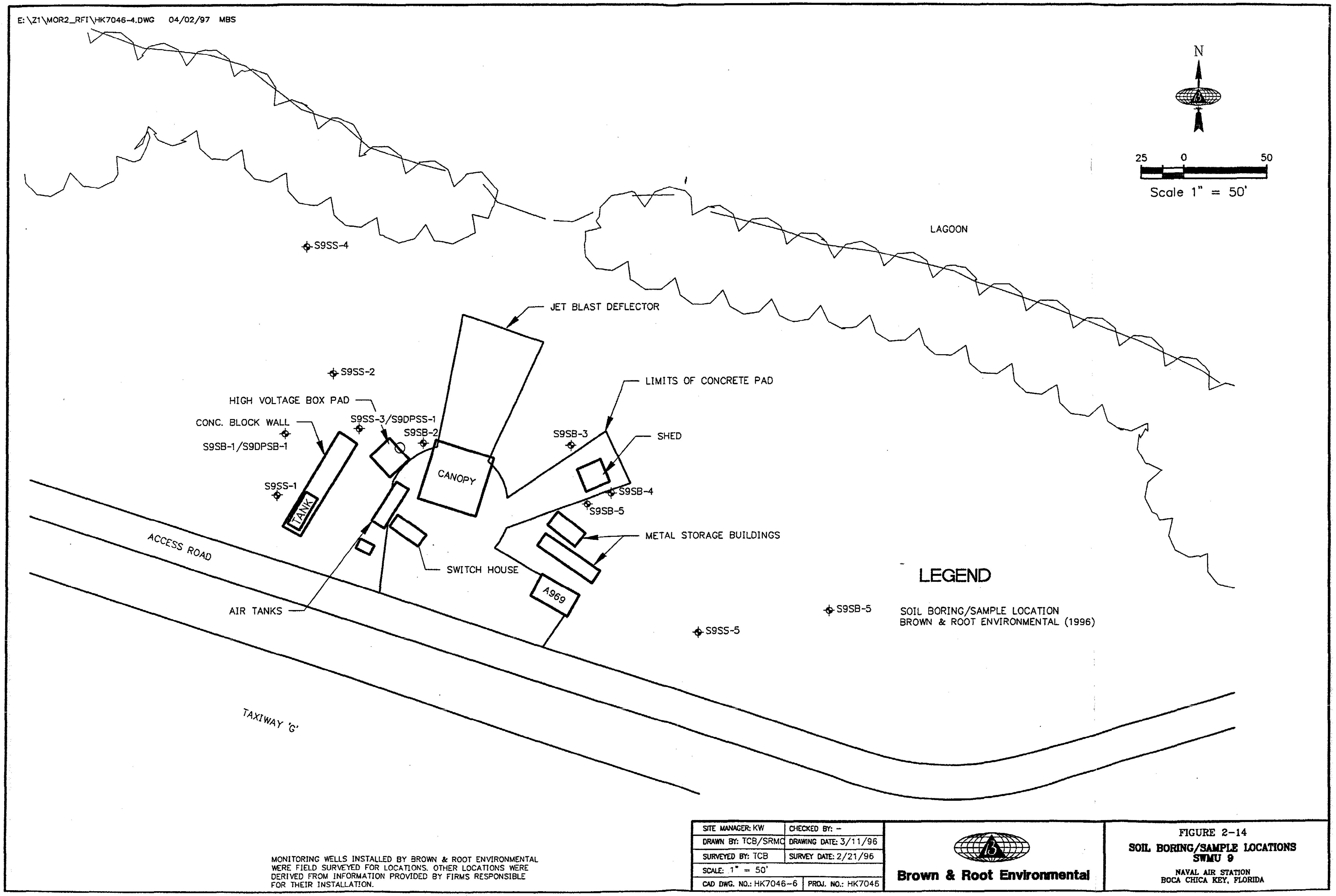
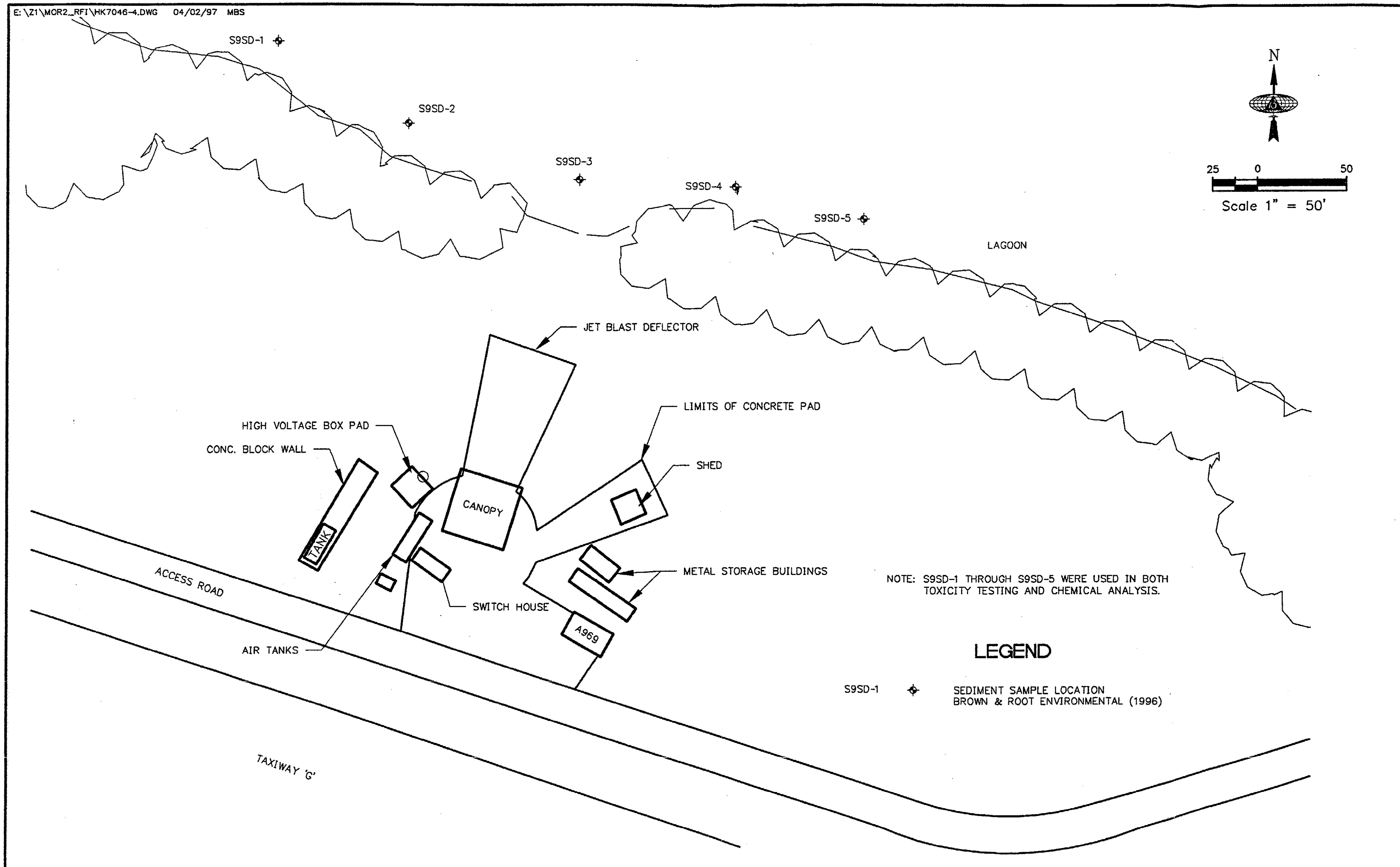


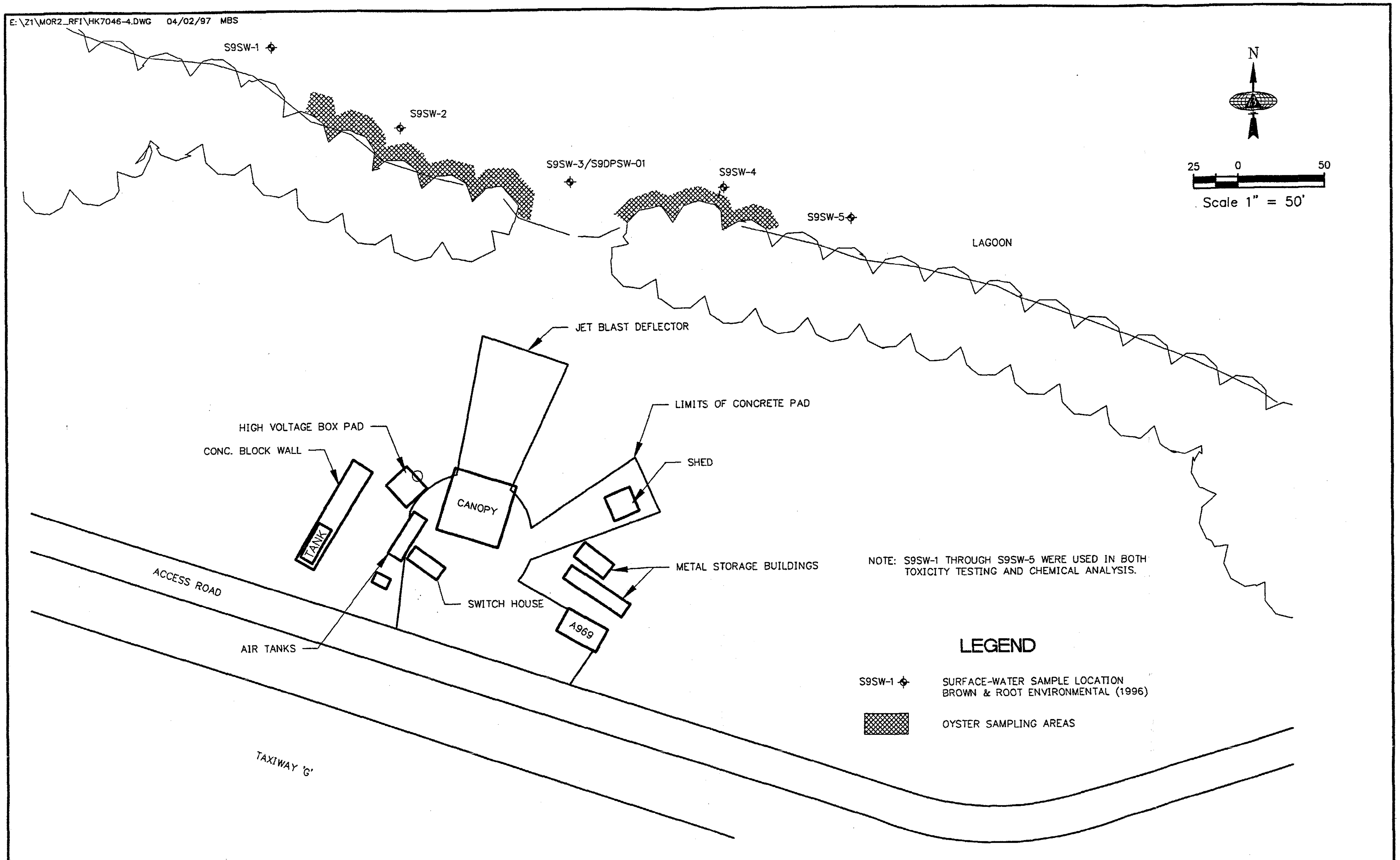
FIGURE 2-14
SOIL BORING/SAMPLE LOCATIONS
SWMU 9



SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/11/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-15
SEDIMENT SAMPLE LOCATIONS
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

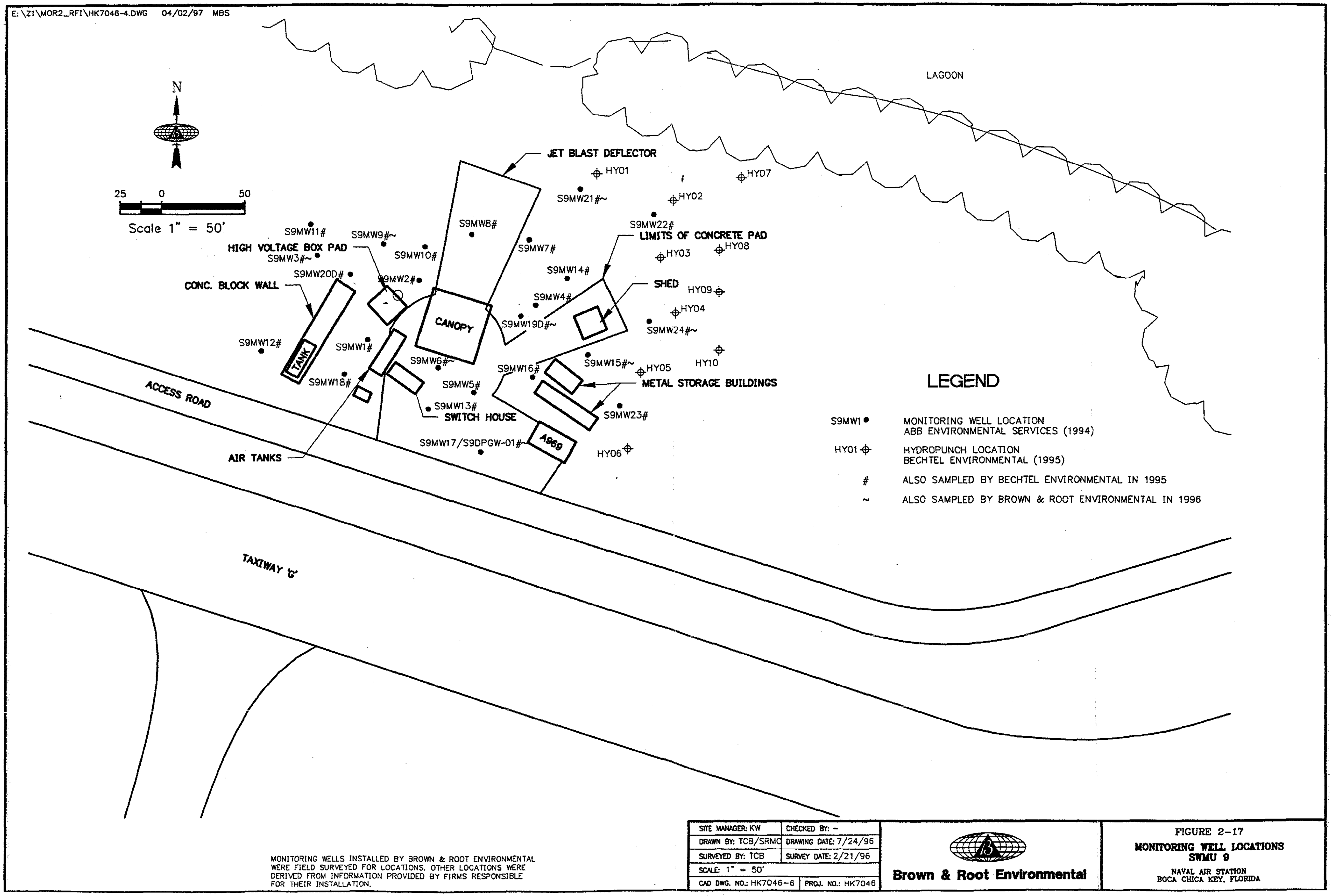


MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 3/11/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 2-16
SURFACE-WATER AND BIOTA SAMPLING LOCATIONS-SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


E:\Z1\MOR2_RFI\HK7046-4.DWG 04/02/97 MBS
N
25 0 50
Scale 1" = 50'
LAGOON
JET BLAST DEFLECTOR
HY01
HY07
HY02
S9MW21#~
S9MW22#
LIMITS OF CONCRETE PAD
HY03
HY08
S9MW8#
S9MW7#
S9MW11#
S9MW9#~
HIGH VOLTAGE BOX PAD
S9MW10#
S9MW3#~
S9MW20D#
S9MW2#
S9MW14#
SHED
HY09
CONC. BLOCK WALL
S9MW4#
HY04
CANOPY
S9MW19D#~
S9MW24#~
S9MW12#
S9MW1#
TANK
HY10
S9MW6#~
S9MW15#~
HY05
S9MW16#
S9MW18#
S9MW5#
METAL STORAGE BUILDINGS
ACCESS ROAD
S9MW13#
SWITCH HOUSE
S9MW23#
S9MW17/S9DPGW-01#~
A969
HY06
AIR TANKS
TAXIWAY 'G'
LEGEND
S9MW1 MONITORING WELL LOCATION ABB ENVIRONMENTAL SERVICES (1994)
HY01 HYDROPUNCH LOCATION BECHTEL ENVIRONMENTAL (1995)
ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1995
~ ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL IN 1996
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: ~
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 50'
CAD DWG. NO.: HK7046-6
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 2-17
MONITORING WELL LOCATIONS
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

conflicting procedural information. In other instances, procedures were not identified. Procedures were developed for the Supplemental RFI/RI that resolved conflicts between the two workplans and filled any voids. These procedures are compiled in Appendix G. In addition, Appendix H contains procedures that required modifications or deviations to the ABB workplan and SAP (ABB, 1995a, 1995b) during the implementation of the field work under the Supplemental RFI/RI.

2.2 DATA QUALITY ASSESSMENT

The data obtained from the January 1996 field sampling at SWMUs 1, 2, 3, and 9 were partially validated using the industry-accepted process described in Section 2.0 of Appendix G. In general, this data assessment process followed Contract Laboratory Program (CLP) Protocol and Naval Facilities Engineering Service Center data quality assessment guidance. All 1996 data received a limited validation review; approximately 10 percent of 1996 data was fully validated. Historical data (Section 1.3 describes previous investigations) were not subjected to any data quality assessment. They were assumed to have been assessed during their investigation activities and were accepted at face value since records of validation were not available. While this assumption might not have been correct for all historical data points, it is conservative. Questionable historical data points in the data set (data that otherwise might have been discarded as false positives or blank contamination if they had undergone a data quality assessment) only increase the potential for making a positive remedial determination for a particular SWMU.

2.3 DATA INTERPRETATION AND PRESENTATION

This section summarizes the data interpretation and presentation process employed for data obtained from SWMUs 1, 2, 3, and 9 during January 1996. B&R Environmental integrated data from previous investigations (see Section 1.3) with data collected during January 1996 to create a comprehensive data set and used this data set in the evaluations and assessments presented in this RFI/RI report. Section 3.0 of Appendix G provides additional detail about the processes discussed in this section.

2.3.1 Data from Analytical Results

The results of the RFI/RI are presented in Sections 4.1 through 4.4 of this report. Each section discusses each SWMU and presents the contaminants detected at the site, the spatial and (if applicable) temporal extent to which contaminants have impacted environmental media, and a relationship between the findings and the activities that occurred during base operations. All of the contaminants detected were compared to applicable or relevant and appropriate requirements (ARARs) and screening action levels

(SALs) for each medium. These ARARs and SALs are shown in Table 2-3, 2-4, 2-5, and 2-6, respectively, for soil, sediment, surface water and groundwater. Section 3.1 in Appendix G contains detailed information on data interpretation for use in estimating the nature and extent of contamination, evaluating chemical fate and transport, and calculating risk to human health and the ecological environment. Estimating the nature and extent of contamination and evaluating chemical fate and transport provide critical information for use in both the human health and ecological risk assessments.

2.3.2 Human Health Risk Assessment

The objectives of the risk assessment were to estimate actual or potential risks to human health from the presence of contamination in surface soil, subsurface soil, sediment, groundwater, and surface water and to provide the basis for determining the need for remedial measures for these media.

B&R Environmental conducted a preliminary risk evaluation (PRE) to determine if each of the four SWMUs required a baseline human health risk assessment. The PRE eliminated unnecessary estimates of risks for SWMUs that do not pose a current or future human health risk. If the risk screening evaluation showed that there are incomplete pathways or that chemical concentrations are present at *de minimus* levels, then no further human health risk assessment was necessary; this was the case for SWMUs 3 and 9. However, if the PRE indicated risks that exceeded those appropriate for the future use scenario for a particular site, then B&R Environmental performed a risk assessment that quantified risks associated with that SWMU. Such risk assessments were performed for SWMUs 1 and 2.

The risk assessment estimated the potential for human health risk attributable to SWMUs 1 and 2. Information on the toxicity of the compounds detected in the various media, the distribution of contamination, potential migration pathways, and a SWMU-specific estimate of chemical intake via assumed exposure routes were combined to estimate potential risks.

The risk assessment processes were performed in accordance with current EPA risk assessment guidance (EPA, 1989; EPA, 1991; EPA, 1995a) and as also referenced in the Supplemental RFI/RI workplan (ABB, 1995a). Detailed procedures for the risk assessment processes are included in Appendix G, Section 3.2.

TABLE 2-3

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SOIL
NAS KEY WEST
PAGE 1 OF 3

COPCs	ORNL BTVs(1)	USEPA REG III BTVs(2)	RCRA ALs(3)	RPRGs(4)	FDEP Res Goals(5)	FDEP Indust. Goals(6)	Most Restrictive ARAR or SAL		Units
							Concentration	Source	
INORGANICS									
Aluminum	600	NA	200,000	783,000	75,000	>1,000,000	600	ORNL BTVs	mg/kg
Antimony	NA	NA	32	108	26	220	26	FDEP Res. Goals	mg/kg
Arsenic	60	NA	0.4	0.356	0.8	3.7	0.356	RPRGs	mg/kg
Barium	3,000	440	5,600	18,900	5,200	84,000	440	USEPA REG III BTVs	mg/kg
Beryllium	NA	NA	0.2	0.149	0.2	1.0	0.149	RPRGs	mg/kg
Cadmium	20	NA	40	270	37	600	20	ORNL BTVs	mg/kg
Chromium	0.4	0.0075	400	1,350	290	430	0.0075	USEPA REG III BTVs	mg/kg
Cobalt	1,000	200	5,000	16,200	4,700	110,000	200	USEPA REG III BTVs	mg/kg
Copper	50	NA	NA	NA	NA	NA	50	ORNL BTVs	mg/kg
Cyanide	NA	0.005	1,600	5,400	1,600	40,000	0.005	USEPA REG III BTVs	mg/kg
Lead	500	NA	400	NA	500	1,000	400	RCRA ALs	mg/kg
Manganese	100	NA	400	NA	370	5,500	100	ORNL BTVs	mg/kg
Mercury	0.1	NA	20	81	23	480	0.1	ORNL BTVs	mg/kg
Nickel	200	NA	1,600	5,400	1,500	26,000	200	ORNL BTVs	mg/kg
Selenium	70	NA	400	1,350	390	9,900	70	ORNL BTVs	mg/kg
Silver	50	NA	400	1,350	390	9,000	50	ORNL BTVs	mg/kg
Tin	2,000	0.89	50,000	162,000	44,000	670,000	0.89	USEPA REG III BTVs	mg/kg
Vanadium	20	NA	720	1,890	490	4,800	20	ORNL BTVs	mg/kg
Zinc	200	NA	24,000	81000	23,000	560,000	200	ORNL BTVs	mg/kg
PESTICIDES/PCBs									
4,4'-DDD	NA	100	3,000	2,667	4,500	17,000	100	USEPA REG III BTVs	µg/kg
4,4'-DDE	NA	100	2,000	1,882	3,000	11,000	100	USEPA REG III BTVs	µg/kg
4,4'-DDT	NA	100	2,000	1,882	3,100	12,000	100	USEPA REG III BTVs	µg/kg
Aldrin	NA	100	40	38	60	200	38	RPRGs	µg/kg
Alpha-BHC	NA	NA	100	102	NA	NA	100	RCRA ALs	µg/kg

TABLE 2-3

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SOIL
NAS KEY WEST
PAGE 2 OF 3

COPCs	ORNL BTVs[1]	USEPA REG III BTVs[2]	RCRA ALs[3]	RPRGs[4]	FDEP Res Goals[5]	FDEP Indust. Goals[6]	Most Restrictive ARAR or SAL Concentration	Most Restrictive ARAR or SAL Source	Units
PESTICIDES/PCBs (cont.)									
Aroclor-1260	NA	NA	90	83	900	3,500	83	RPRGs	µg/kg
Beta-BHC	NA	NA	4,000	356	NA	NA	356	RPRGs	µg/kg
Endosulfan I	NA	100	NA	NA	390,000	5,900,000	100	USEPA REG III BTVs	µg/kg
Endosulfan II	NA	100	4,000	1,620,000	NA	NA	100	USEPA REG III BTVs	µg/kg
Endosulfan sulfate	NA	100	NA	NA	NA	NA	100	USEPA REG III BTVs	µg/kg
Endrin	NA	100	20,000	81,000	23,000	470,000	100	USEPA REG III BTVs	µg/kg
Endrin aldehyde	NA	100	NA	NA	23,000	480,000	100	USEPA REG III BTVs	µg/kg
Endrin ketone	NA	100	NA	NA	NA	NA	100	USEPA REG III BTVs	µg/kg
Gamma-BHC (lindane)	NA	100	500	492	NA	NA	100	USEPA REG III BTVs	µg/kg
Heptachlor epoxide	NA	100	80	NA	100	300	80	RCRA ALs	µg/kg
Methoxychlor	NA	100	NA	NA	NA	NA	100	USEPA REG III BTVs	µg/kg
Toxaphene	NA	NA	600	NA	900	3,000	600	RCRA ALs	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS									
Acetophenone	NA	NA	8,000,000	NA	NA	NA	8,000,000	RCRA ALs	µg/kg
Anthracene	NA	100	20,000,000	81,000,000	20,000,000	300,000,000	100	USEPA REG III BTVs	µg/kg
Benzo(a)anthracene	NA	100	1000	877	1,400	4,900	100	USEPA REG III BTVs	µg/kg
Benzo(a)pyrene	NA	100	95.9	88	100	500	88	RPRGs	µg/kg
Benzo(b)fluoranthene	NA	100	959	877	1,400	5,000	100	USEPA REG III BTVs	µg/kg
Benzo(g,h,i)perylene	NA	100	NA	NA	14,000	50,000	100	USEPA REG III BTVs	µg/kg
Benzo(k)fluoranthene	NA	100	10,000	8,767	14,000	48,000	100	USEPA REG III BTVs	µg/kg
Bis(2-ethylhexyl)phthalate	NA	NA	6,000	45,714	48,000	110,000	6,000	RCRA ALs	µg/kg
Chrysene	NA	100	9,590	87,671	140,000	500,000	100	USEPA REG III BTVs	µg/kg
Di-n-butyl phthalate	NA	NA	8,000,000	NA	7,300,000	140,000,000	8,000,000	RCRA ALs	µg/kg
Dibenzo(a,h)anthracene	NA	100	100	88	100	500	88	RPRGs	µg/kg
Fluoranthene	NA	100	3,360,000	10,800,000	2,900,000	48,000,000	100	USEPA REG III BTVs	µg/kg

TABLE 2-3

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SOIL NAS KEY WEST

COPCs	ORNL BTVs[1]	USEPA REG III BTVs[2]	RCRA ALs[3]	RPRGs[4]	FDEP Res Goals[5]	FDEP Indust. Goals[6]	Most Restrictive ARAR or SAL		Units
							Concentration	Source	
SEMIVOLATILE ORGANIC COMPOUNDS (cont.)									
Hexachlorophene	NA	NA	20,000	NA	NA	NA	20,000	RCRA ALs	µg/kg
Indeno(1,2,3-cd)pyrene	NA	100	1,000	877	1,400	5,000	100	USEPA REG III BTVs	µg/kg
Naphthalene	NA	NA	3,200,000	NA	1,300,000	12,000,000	1,300,000	FDEP Res Goals	µg/kg
Pyrene	NA	100	2,400,000	8,100,000	2,200,000	41,000,000	100	USEPA REG III BTVs	µg/kg
VOLATILE ORGANIC COMPOUNDS									
1,1,2,2-tetrachloroethane	NA	300	35,000	3,200	900	1,400	300	USEPA REG III BTVs	µg/kg
1,1,1,2-tetrachloroethane	NA	NA	300,000	NA	5,900	8,900	5,900	FDEP Res Goals	µg/kg
1,2,3-trichloropropane	NA	NA	500,000	1,620,000	NA	NA	500,000	RCRA ALs	µg/kg
2-butanone	NA	NA	48,000,000	162,000,000	2,200,000	15,000,000	2,200,000	FDEP Res Goals	µg/kg
Acetone	NA	NA	8,000,000	27,000,000	260,000	1,800,000	260,000	FDEP Res Goals	µg/kg
Acetonitrile	NA	NA	500,000	1,620,000	NA	NA	500,000	RCRA Als	µg/kg
Cis-1,2-dichloroethene	NA	300	800,000	2,700,000	26,000	180,000	300	USEPA REG III BTVs	µg/kg
Ethylbenzene	NA	100	8,000,000	27,000,000	1,400,000	10,000,000	100	USEPA REG III BTVs	µg/kg
Methylene chloride	NA	300	93,300	85,333	16,000	23,000	300	USEPA REG III BTVs	µg/kg
Toluene	NA	100	16,000,000	54,000,000	520,000	3,500,000	100	USEPA REG III BTVs	µg/kg
Trans-1,4-dichloro-2-butene	NA	1,000	NA	NA	NA	NA	1,000	USEPA REG III BTVs	µg/kg
Xylenes (total)	NA	100	160,000,000	540,000,000	13,000,000	92,000,000	100	USEPA REG III BTVs	µg/kg

1 Oak Ridge National Laboratory Benchmark Toxicity Value (Will and Suter, 1994).
2 USEPA Region III Benchmark Toxicity Values (EPA, 1995e).
3 40 CFR Part 264 Proposed RCRA Action Levels for Soil.
4 Residential/Preliminary Remediation Goals (IT, 1994).
5 Florida Department of Environmental Protection Residential Soil Cleanup Goals (FDEP, 1995b and 1996).
6 Florida Department of Environmental Protection Industrial Soil Cleanup Goals (FDEP, 1995b and 1996).

TABLE 2-4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SEDIMENT
NAS KEY WEST
PAGE 1 OF 3

COPCs	FDEP Criteria[1]	EPA REG IV[2]	FederaL[3]	ER-L[4]	ER-M[5]	USEPA SQB[6]	Other	RCRA ALs[7]	Most restrictive ARAR or SAL		Units
									Concentration	Source	
INORGANICS											
Aluminum	NA	NA	NA	NA	NA	NA	NA	200,000	200,000	RCRA ALs	mg/kg
Antimony	NA	12	NA	2	NA	NA	NA	32	2	ER-L	mg/kg
Arsenic	7.24	7.24	NA	8.2	70	NA	NA	0.4	0.4	RCRA ALs	mg/kg
Barium	NA	NA	NA	NA	NA	NA	40[8]	5,600	40	OTHER	mg/kg
Beryllium	NA	NA	NA	NA	NA	NA	NA	0.2	0.2	RCRA ALs	mg/kg
Cadmium	0.676	1	NA	1.2	9.6	NA	NA	40	0.676	FDEP	mg/kg
Chromium	52.3	52.3	NA	81	370	NA	NA	400	52.3	EPA REG IV	mg/kg
Cobalt	NA	NA	NA	NA	NA	NA	NA	5,000	5,000	RCRA ALs	mg/kg
Copper	18.7	18.7	NA	34	270	NA	NA	NA	18.7	EPA REG IV	mg/kg
Cyanide	NA	NA	NA	NA	NA	NA	0.1[10]	1,600	0.1	OTHER	mg/kg
Lead	30.2	30.2	NA	47	218	NA	NA	400	30.2	EPA REG IV	mg/kg
Manganese	NA	NA	NA	NA	NA	NA	460[9]	400	400	RCRA ALs	mg/kg
Mercury	0.13	0.13	NA	0.15	0.71	NA	NA	20	0.13	EPA REG IV	mg/kg
Nickel	15.9	15.9	NA	21	51.6	NA	NA	1,600	15.9	EPA REG IV	mg/kg
Selenium	NA	NA	NA	NA	NA	NA	NA	400	400	RCRA ALs	mg/kg
Silver	0.733	2	NA	1	3.7	NA	NA	400	0.733	FDEP	mg/kg
Vanadium	NA	NA	NA	NA	NA	NA	NA	720	720	RCRA ALs	mg/kg
Zinc	124	124	NA	150	410	NA	NA	24,000	124	EPA REG IV	mg/kg
PESTICIDES/PCBs											
4,4'-DDD	NA	3.3	NA	1.6	46	NA	NA	3,000	1.6	ER-L	µg/kg
4,4'-DDE	1.22	3.3	NA	2.2	27	NA	NA	2,000	1.22	FDEP	µg/kg
4,4'-DDT	2.07	3.3	NA	1.6	46	NA	NA	2,000	1.6	ER-L	µg/kg
Aldrin	NA	NA	NA	NA	NA	NA	NA	40	40	RCRA ALs	µg/kg
Beta-BHC	NA	NA	NA	NA	NA	NA	5[9]	NA	5	OTHER	µg/kg
Delta-BHC	NA	NA	NA	NA	NA	NA	3[9]	NA	3	OTHER	µg/kg

TABLE 2-4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SEDIMENT
NAS KEY WEST
PAGE 2 OF 3

COPCs	FDEP Criteria[1]	EPA REG IV[2]	FederaL[3]	ER-L[4]	ER-M[5]	USEPA SQB[6]	Other	RCRA ALs[7]	Most restrictive ARAR or SAL		Units
									Concentration	Source	
PESTICIDES/PCBs (cont.)											
Dieldrin	0.715	3.3	95	NA	NA	NA	NA	40	0.715	FDEP	µg/kg
Endosulfan I	NA	NA	NA	NA	NA	5.4	NA	NA	5.4	USEPA SQB	µg/kg
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	4,000	4,000	RCRA ALs	µg/kg
Endrin	NA	3.3	3.5	NA	NA	NA	NA	20,000	3.3	EPA REG IV	µg/kg
Endrin aldehyde	NA	NA	3.5	NA	NA	NA	NA		3.5	FEDERAL	µg/kg
Gamma-BHC (lindane)	NA	NA	NA	NA	NA	NA	NA	500	500	RCRA ALs	µg/kg
Heptachlor	NA	NA	NA	NA	NA	NA	NA	200	200	RCRA ALs	µg/kg
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	80	80	RCRA ALs	µg/kg
Toxaphene	NA	NA	NA	NA	NA	NA	NA	600	600	RCRA ALs	µg/kg
SEMIVOLATILE ORGANIC COMPOUNDS											
Acetophenone	NA	NA	NA	NA	NA	NA	NA	8,000,000	8,000,000	RCRA ALs	µg/kg
Benzo(a)pyrene	88.8	330	NA	430	1,600	NA	NA	95.9	88.8	FDEP	µg/kg
Benzo(b)fluoranthene	NA	NA	NA	330	1,700	NA	NA	959	330	ER-L	µg/kg
Benzo(g,h,i)perylene	NA	NA	NA	330	1,700	NA	NA	NA	330	ER-L	µg/kg
Bis(2-ethylhexyl)phthalate	182	182	NA	NA	NA	NA	890,000,000[10]	6,000	182	EPA REG IV	µg/kg
Chrysene	108	330	NA	384	280	NA	NA	9,590	108	FDEP	µg/kg
Di-n-butyl phthalate	NA	NA	NA	NA	NA	11,000	NA	8,000,000	11,000	USEPA SQB	µg/kg
Dibenzo(a,h)anthracene	6.22	330	NA	63.4	260	NA	NA	NA	6.22	FDEP	µg/kg
Fluoranthene	113	330	1,400	600	5,100	NA	NA	3,360,000	113	FDEP	µg/kg
Hexachlorophene	NA	NA	NA	NA	NA	NA	NA	20,000	20,000	RCRA ALs	µg/kg
Indeno(1,2,3-cd)pyrene	NA	NA	655	1,700	9,600	NA	NA	1,000	655	FEDERAL	µg/kg
Pyrene	153	330	NA	665	2,600	NA	NA	2,400,000	153	FDEP	µg/kg

TABLE 2-4

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SEDIMENT
NAS KEY WEST
PAGE 3 OF 3

COPCs	FDEP Criteria(1)	EPA REG IV(2)	FederaL(3)	ER-L(4)	ER-M(5)	USEPA SQB(6)	Other	RCRA ALs(7)	Most restrictive ARAR or SAL Concentration	Source	Units
VOLATILE ORGANIC COMPOUNDS											
2-butanone	NA	NA	NA	NA	NA	NA	NA	48,000,000	48,000,000	RCRA Als	µg/kg
Acetone	NA	NA	NA	NA	NA	NA	64	8,000,000	64	OTHER	µg/kg
Carbon disulfide	NA	NA	NA	NA	NA	NA	13(10)	8,000,000	13	OTHER	µg/kg
Cis-1,2-dichloroethene	NA	NA	NA	NA	NA	NA	23(9)	800,000	23	OTHER	µg/kg
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	8,000	8000	RCRA ALs	µg/kg
Methylene chloride	NA	NA	NA	NA	NA	NA	427(10)	93,300	427	OTHER	µg/kg
Tetrachloroethene	NA	NA	NA	NA	NA	530	NA	800,000	530	USEPA SQB	µg/kg
Toluene	NA	NA	NA	NA	NA	670	NA	16,000,000	670	USEPA SQB	µg/kg
Xylenes (total)	NA	NA	NA	NA	NA	25	NA	160,000,000	25	USEPA SQB	µg/kg

1 Florida Department of Environmental Protection Sediment Quality Guideline (FDEP, 1994).
2 EPA Region IV Sediment Screening Values (EPA, 1995e).
3 Federal Sediment Quality Screening Criteria (EPA, 1996).
4 Effects Range-Low (Long et. al., 1995; Long and Morgan, 1991).
5 Effects Range-Medium (Long et. al., 1995; Long and Morgan, 1991).
6 USEPA Sediment Quality Benchmark (EPA, 1996).
7 40 CFR Part 264 Proposed RCRA Action Levels for Soil.
8 Baudo, et. al., 1990.
9 Hull And Suter, 1994.
10 OME, 1992.

TABLE 2-5

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR SURFACE WATER NAS KEY WEST PAGE 1 OF 2

COPCs	FDEP Criteria[1]	EPA Criteria[2]	National Criteria[3]	REG III Marine[4]	REG III Fresh[5]	RCRA ALs[6]	Most Restrictive ARAR or SAL		Units
							Concentration	Source	
HERBICIDES									
2,4-D	100	NA	NA	NA	NA	NA	100	FDEP Criteria	µg/L
INORGANICS									
Aluminum	1,500	NA	NA	NA	NA	NA	1,500	FDEP Criteria	µg/L
Antimony	4,300	NA	NA	NA	NA	10	10	RCRA AL	µg/L
Arsenic	50	36	36	NA	NA	50	36	EPA Criteria	µg/L
Barium	NA	NA	NA	10,000	NA	1,000	1,000	RCRA AL	µg/L
Beryllium	0.13	NA	NA	NA	NA	0.008	0.008	RCRA AL	µg/L
Cadmium	9.3	9.3	9.3	NA	NA	10	9.3	EPA Criteria	µg/L
Copper	2.9	2.9	2.4	NA	NA	NA	2.4	National Criteria	µg/L
Cyanide	1	NA	1	NA	NA	700	1	FDEP Criteria	µg/L
Lead	5.6	8.5	8.1	NA	NA	50	5.6	FDEP Criteria	µg/L
Manganese	NA	NA	NA	10	NA	NA	10	REG III Marine	µg/L
Mercury	0.025	0.025	1.1	NA	NA	2	0.025	EPA Criteria	µg/L
Nickel	8.3	8.3	8.2	NA	NA	700	8.2	National Criteria	µg/L
Sulfide	NA	2	NA	NA	NA	NA	2	EPA Criteria	µg/L
Thallium	6.3	21.3	NA	NA	NA	NA	6.3	FDEP Criteria	µg/L
Tin	NA	NA	NA	0.01	NA	NA	0.01	REG III Marine	µg/L
Vanadium	NA	NA	NA	10,000	NA	NA	10,000	REG III Marine	µg/L
Zinc	86	86	81	NA	NA	NA	81	National Criteria	µg/L
PESTICIDES/PCBs									
4,4'-DDD	0.001	0.025	NA	NA	NA	0.1	0.025	FDEP Criteria	µg/L
4,4'-DDT	0.0006	0.001	NA	NA	NA	0.1	0.0006	FDEP Criteria	µg/L
Beta-BHC	0.046	NA	NA	NA	NA	0.2	0.046	FDEP Criteria	µg/L
Heptachlor	0.00021	0.0036	NA	NA	NA	0.008	0.00021	FDEP Criteria	µg/L

TABLE 2-5

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)
AND SCREENING ACTION LEVELS (SALs) FOR SURFACE WATER
NAS KEY WEST
PAGE 2 OF 2

COPCs	FDEP Criteria(1)	EPA Criteria(2)	National Criteria(3)	REG III Marine(4)	REG III Fresh(5)	RCRA ALs(6)	Most Restrictive ARAR or SAL: Concentration	Most Restrictive ARAR or SAL: Source	Units
SEMIVOLATILE ORGANIC COMPOUNDS									
Bis(2-ethyhexyl)phthalate	NA	NA	NA	360	NA	3	3	RCRA AL	µg/L
Chrysene	31	NA	NA	NA	NA	NA	31	FDEP Criteria	µg/L
Di-n-butyl phthalate	NA	NA	NA	3.4	NA	4,000	3.4	REG III Marine	µg/L
Fluoranthene	370	NA	NA	NA	NA	NA	370	FDEP Criteria	µg/L
Pyrene	11,000	NA	NA	NA	NA	NA	11,000	FDEP Criteria	µg/L
VOLATILE ORGANIC COMPOUNDS									
Acetone		NA	NA	NA	90,000,000	4,000	4,000	RCRA AL	µg/L
Carbon disulfide	NA	NA	NA	2	NA	4,000	2	REG III Marine	µg/L
Methylene chloride	1,580	NA	NA	NA	NA	5	5	RCRA AL	µg/L

1 Florida Department of Environmental Protection Surface Water Quality Criteria (FDEP, 1995a).
2 USEPA Region IV Chronic Surface Water Screening Values (EPA, 1995d).
3 National Ambient Water Quality Standards (EPA, 1996).
4 USEPA Region III Marine Standards (EPA, 1995e).
5 USEPA Region III Fresh Water Standards (EPA, 1995e).
6 40 CFR Part 264 Proposed RCRA Action Levels for Water.

TABLE 2-6

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS) AND SCREENING ACTION LEVELS (SALs) FOR GROUNDWATER NAS KEY WEST PAGE 1 OF 2

COPCs	MCL(1)	FL MCL(2)	RCRA AL(3)	FDEP GC(4)	Most Restrictive ARAR or SAL Concentration	Most Restrictive ARAR or SAL Source	Units
HERBICIDES							
Methyl parathion	NA	NA	9	NA	9	RCRA AL	µg/L
INORGANICS							
Aluminum	NA	200	NA	NA	200	FL MCL	µg/L
Antimony	6	6	10	29	6	MCL	µg/L
Arsenic	50	50	50	50	50	MCL	µg/L
Barium	2,000	2,000	1,000	1,000	1,000	RCRA AL	µg/L
Beryllium	4	4	0.008	5	0.008	RCRA AL	µg/L
Cadmium	5	5	10	10	5	MCL	µg/L
Chromium	100	100	NA	50	50	FDEP GC	µg/L
Copper	1,300	1,000	NA	1,000	1,000	FL MCL	µg/L
Cyanide	200	200	700	154	154	FDEP GC	µg/L
Lead	15	15	50	50	15	MCL	µg/L
Manganese	50	50	NA	50	50	MCL	µg/L
Mercury	2	2	2	2	2	MCL	µg/L
Selenium	50	NA	NA	NA	50	MCL	µg/L
Silver	NA	100	50	50	50	RCRA AL	µg/L
Thallium	2	2	NA	10	2	MCL	µg/L
Zinc	NA	5000	NA	5,000	5,000	FL MCL	µg/L
PESTICIDES/PCBs							
4,4'-DDD	NA	NA	0.1	NA	0.1	RCRA AL	µg/L
4,4'-DDE	NA	NA	0.1	NA	0.1	RCRA AL	µg/L
4,4'-DDT	NA	NA	0.1	0.1	0.1	RCRA AL	µg/L
Aldrin	NA	NA	0.002	0.05	0.002	RCRA AL	µg/L
Alpha-BHC	NA	NA	0.006	0.05	0.006	RCRA AL	µg/L
Beta-BHC	NA	NA	0.2	0.05	0.05	FDEP GC	µg/L
Delta-BHC	NA	NA	NA	0.05	0.05	FDEP GC	µg/L
Dieldrin	NA	NA	0.002	0.05	0.002	RCRA AL	µg/L
Endrin	2	NA	NA	NA	2	MCL	µg/L
SEMIVOLATILE ORGANIC COMPOUNDS							
1,2,4-trichlorobenzene	70	NA	700	NA	70	MCL	µg/L
1,2-dichlorobenzene	600	600	NA	10	10	FDEP GC	µg/L
1,3-dichlorobenzene	600	600	NA	10	10	FDEP GC	µg/L
1,4-dichlorobenzene	75	75	NA	75	75	MCL	µg/L
2,4-dimethylphenol	NA	NA	NA	400	400	FDEP GC	µg/L
3,3'-dimethylbenzidine	NA	NA	0.08	NA	0.08	RCRA AL	µg/L
Acenaphthylene	NA	NA	NA	10	10	FDEP GC	µg/L
Benzo(a)pyrene	0.2	NA	NA	NA	0.2	MCL	µg/L
Benzo(k)fluoranthene	0.2	NA	NA	10	0.2	MCL	µg/L
Bis(2-ethylhexyl)phthalate	6	6	3	14	3	RCRA AL	µg/L
Chrysene	NA	NA	NA	10	10	FDEP GC	µg/L
Diethyl phthalate	NA	NA	30,000	NA	30,000	RCRA AL	µg/L
Fluorene	NA	NA	NA	10	10	FDEP GC	µg/L
Naphthalene	NA	NA	NA	10	10	FDEP GC	µg/L
Phenanthrene	NA	NA	NA	10	10	FDEP GC	µg/L
Pyrene	NA	NA	NA	10	10	FDEP GC	µg/L

TABLE 2-6

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND SCREENING ACTION LEVELS (SALs) FOR GROUNDWATER NAS KEY WEST PAGE 2 OF 2

COPCs	MCL[1]	FL MCL[2]	RCRA AL[3]	FDEP GC[4]	Most Restrictive ARAR or SAL Concentration	Most Restrictive ARAR or SAL Source	Units
VOLATILE ORGANIC COMPOUNDS							
1,1,1-trichloroethane	200	200	3,000	200	200	MCL	μg/L
1,1,2,2-tetrachloroethane	NA	NA	2	NA	2	RCRA AL	μg/L
1,1,2-trichloroethane	5	NA	6	NA	5	MCL	μg/L
1,1-dichloroethane	NA	NA	NA	2,400	2,400	FDEP GC	μg/L
1,1-dichloroethene	7	NA	NA	NA	7	MCL	μg/L
1,2-dichloroethane	5	NA	NA	NA	5	MCL	μg/L
1,2-dichloroethene (total)	170	NA	NA	4.2	4.2	FDEP GC	μg/L
1,2-dichloropropane	5	NA	NA	NA	5	MCL	μg/L
2-butanone	NA	NA	2,000	170	170	FDEP GC	μg/L
Acetone	NA	NA	4,000	700	700	FDEP GC	μg/L
Benzene	5	1	NA	1	1	FL MCL	μg/L
Bromodichloromethane	100	NA	0.03	NA	0.03	RCRA AL	μg/L
Bromoform	100	NA	700	NA	100	MCL	μg/L
Bromomethane	NA	NA	50	NA	50	RCRA AL	μg/L
Carbon disulfide	NA	NA	4,000	4,000	4,000	RCRA AL	μg/L
Carbon tetrachloride	5	NA	0.3	NA	0.3	RCRA AL	μg/L
Chlorobenzene	NA	100	700	10	10	FDEP GC	μg/L
Chlorodibromomethane	100	NA	NA	NA	100	MCL	μg/L
Chloroform	100	NA	6	NA	6	RCRA AL	μg/L
Cis-1,2-dichloroethene	70	70	NA	4.2	4.2	FDEP GC	μg/L
Ethylbenzene	700	700	4,000	2	2	FDEP GC	μg/L
m-Xylene	10,000	NA	NA	NA	10,000	MCL	μg/L
Methylene chloride	NA	NA	5	5	5	RCRA AL	μg/L
o+p-Xylenes	10,000	NA	NA	NA	10,000	MCL	μg/L
Styrene	100	NA	7,000	NA	100	MCL	μg/L
Tetrachloroethene	5	NA	0.7	NA	0.7	RCRA AL	μg/L
Toluene	1,000	1,000	10,000	240	240	FDEP GC	μg/L
Trans-1,2-dichloroethene	100	100	NA	4.2	4.2	FDEP GC	μg/L
Trichloroethene	5	NA	NA	NA	5	MCL	μg/L
Vinyl chloride	2	1	NA	1	1	FL MCL	μg/L
Xylenes (total)	10,000	10,000	70,000	50	50	FDEP GC	μg/L

1 Safe Drinking Water Act Maximum Contaminant Level (EPA, 1995c).
2 Florida Maximum Contaminant Level (IT, 1994).
3 40 CFR Part 264 Proposed RCRA Action Levels for Water.
4 Florida Department of Environmental Protection Guidance (FDEP, 1989).

2.3.3 Ecological Risk Assessment

The three main objectives of an RFI/RI are to characterize the nature and extent of contamination at a site, assess potential risks to human health, and assess potential risks to the environment. IT Corporation conducted preliminary screening-level ecological risk assessments at 12 sites as part of its initial RFI/RI at NAS Key West between 1992 and 1994 (IT Corporation, 1994). Potential ecological risks at each site were grouped as "low," "medium," or "high." Table 2-7 lists specific results from this ecological risk grouping. As a result of these conclusions and existing knowledge of the sites, and in consultation with FDEP, additional ecological study was recommended at several sites to determine potential ecological risks from site-related contaminants. Of these 12 sites, SWMUs 1, 2, and 3 were prioritized by FDEP for initial Phase II ecological study. Ecological risks at SWMU 1 were designated as "high" in the Phase I assessment. Contaminants that posed significant potential ecological risks at SWMU 1 included metals, polycyclic aromatic hydrocarbons (PAHs), and pesticides in various media, particularly in surface water and soils. Potential ecological risks at SWMU 2 were also categorized as "high" in the Phase I assessment. Pesticides in sediments and soils were determined to pose the highest potential risks to ecological receptors at this site, and elevated concentrations of some metals were also detected in sediments and soils. For SWMU 3, potential risks were designated as "low." Metals in surface water and sediment were determined to pose the greatest potential risks, and some pesticides, volatile organic compounds (VOCs), and PAHs in sediments were determined to pose significant potential risks. In addition to the Phase I RFI/RI activities at the 12 sites mentioned above, an assessment of groundwater contamination was conducted at SWMU 9, the Jet Engine Test Cell, by ABB Environmental Services (ABB, 1994). Elevated levels of VOCs and semivolatile organic compounds (SVOCs) were detected in site groundwater. Although this site is located next to an inlet of Florida Bay, ecological risks to fish were not investigated because the fish present have open access to ocean waters. Benthic oysters were sampled in place because they are not mobile.

As part of additional Phase II ecological study, toxicity testing using site-specific media samples and tissue analysis using site-specific biological samples were proposed by B&R Environmental to further investigate the potential risks to ecological receptors at SWMUs 1 and 2. Subsequent to this recommendation and in consultation with the Navy, FDEP, and EPA, toxicity testing and tissue analysis were also proposed at SWMUs 3 and 9, along with an initial screening-level assessment at SWMU 9, where no previous ecological investigations had been performed to address FDEP comments. These tests, along with additional sampling and chemical analysis of relevant media at all four SWMUs formed the basis of Phase II investigations. Detailed procedures for the ecological risk assessment processes are included in Appendix G, Section 3.3.

TABLE 2-7

RANKING OF 12 SITES BASED ON RFI/RI PRELIMINARY SCREENING OF ECOLOGICAL RISK[1] SUPPLEMENTAL RFI/RI WORKPLAN NAS KEY WEST

Preliminary Ecological Rank	Site Number	Site Name
High	IR Site-1	Truman Annex Refuse Disposal Area
	IR Site-7	Fleming Key North Landfill
	IR Site-8	Fleming Key South Landfill
	SWMU-1	Boca Chica Open Disposal Area
	SWMU-2	Boca Chica 4,4'-DDT Mixing Area
Medium	SWMU-5	Boca Chica AIMD Building A-990
	SWMU-7	Boca Chica Building A-825
	AOC-A[2]	Demolition Key Open Disposal Area
	AOC-B[2]	Big Coppitt Key Abandoned Civilian Disposal Area
Low	SWMU-3	Boca Chica Fire-Fighting Training Area
	SWMU-4	Boca Chica AIMD Building A-980
	IR Site-3	Truman Annex 4,4'-DDT Mixing Area

1 Source: IT Corporation, 1994.
2 Ranked by ABB.

Notes: RFI/RI = Resource Conservation and Recovery Act (RCRA) Facility Investigation and Remedial Investigation.
PRE = Preliminary Risk Evaluation.
IR = Installation Restoration.
SWMU = Solid Waste Management Unit.
DDT = Dichlorodiphenyltrichloroethane.
AIMD = Aircraft Intermediate Maintenance Department.
AOC = Area of Concern.

2.4 DETERMINATION OF BACKGROUND LEVELS

Background levels are a necessary component of an RFI/RI. Knowledge of levels of constituents in background areas is necessary in order to evaluate whether contaminants detected at a site have been released from that source or were previously present. Also, background levels are very significant in determination of human health and ecological risk.

The background data set consisted of samples collected from site-specific locations (SWMU 1, SWMU 2, SWMU 3, SWMU 4, and SWMU 7) and from three facility-wide locations chosen to represent Boca Chica Key as a whole (BG 1, BG 2, and BG 3). The facility-wide background locations were selected based upon a review of historical maps, historical aerial photographs, and field visits. Groundwater, surface water, sediment, and soil samples were collected from the site-specific background locations. At each of the three facility-wide locations, soil, sediment, surface water, and biological samples were collected for chemical analysis, while sediment, surface water, and soil samples were collected for toxicity tests. Biological samples consisted of fish at BG 1, BG 2, and BG 3, and mangrove oysters at BG 3.

The development of the background data set occurred in three general steps. In the first step, potentially usable background locations were selected based on physical location, and data from the previous studies were combined with samples collected during January 1996. This step included the discarding of data collected by previous contractors from areas that could have been affected by site operations. The second step involved the removal of data that could bias the statistical results. For example, data outliers (constituents detected at unusually high values when compared to other background samples) were removed from the background data set. The third step involved the statistical evaluation of the final background data set.

For the ecological and human health risk assessments, inorganic contaminants in soil, sediment, groundwater (ecological risk assessment only) and surface water whose maximum detected concentration was less than twice the average background concentration were excluded as contaminants of potential concern for that particular medium. Concentrations of analytes in fish and oyster tissue collected at background sites were compared to values collected in the same species at SWMUs 1, 2, 3, and 9 in the ecological risk assessment for each SWMU. The results of toxicity tests performed using samples collected from some background sites were unclear, and thus, were not used in the ecological risk assessment. Instead, to interpret the results of the toxicity tests, the results using SWMU-related samples were compared to the results of tests conducted using laboratory controls.

A detailed explanation of the development and use of the background data set can be found in Section 4.0 of Appendix G (Procedures) and in Appendix J (Background Report for Boca Chica Key).

The background data set for Boca Chica Key appears sufficient for an accurate characterization of background conditions.

3.0 BASE ENVIRONMENTAL SETTING

3.1 CLIMATE AND METEOROLOGY

Of the Florida Keys, the lower Keys have the lowest rainfall, 35 to 40 inches per year, with an average annual rainfall of 39.4 inches. Temperature is fairly uniform across the Florida Keys with a July average temperature of 84 degrees Fahrenheit (°F), a January average temperature of 64 to 70°F, and an average annual temperature of 76.3°F. Freezing temperatures are rare in the Florida Keys due to the proximity to the Gulf Stream and the Gulf of Mexico, both of which modify advancing cold fronts. Freezes, when they occur, have the long-lasting effect of killing cold-sensitive species that might otherwise become established. Easterly tradewinds and sea breezes suppress summer heat from June to September (IT Corporation, 1994).

Hurricanes normally form in the warm, moist air over the tropical seas around the Lesser Antilles and occasionally in the Caribbean. They tend to move in a westerly to northwesterly direction, gradually turning northward and eastward. Most hurricanes that approach Key West do so from the south and east. Severe hurricanes have struck Key West from each direction. Tidal flooding causes an estimated 75 percent of all damage that occurs during a hurricane (IT Corporation, 1994).

Precipitation is characterized by dry and wet seasons. From December through May, the Keys receive approximately 25 percent of their annual precipitation total. Approximately 75 to 80 percent of the annual rainfall falls from June through November. Rainfall usually occurs in advance of a cold front in the form of a few heavy showers, occasionally five to eight light showers per month. Overland flow or storm drains that drain approximately 50 percent of the island's surface area carry rainfall runoff from Key West to the tidal waters; however, much of the rainfall percolates directly into the subsurface (IT Corporation, 1994).

3.2 TOPOGRAPHY

The Naval Air Station (NAS) Key West Complex is in the southeastern Coastal Plain physiographic province. The topography of the Coastal Plain in southern Florida is controlled by a series of ancient marine reefs that formed during the Pleistocene period when the sea level was higher than it is at present (ABB, 1995a).

Ground elevations in the Key West area average between 4 and 5 feet above mean sea level (msl), and the highest point on Key West is approximately 18 feet above msl. The area is characterized by a sparse veneer of residual soil and surface vegetation overlying eroded limestone. The topography of the lower Keys is generally smooth and flat in the center of the key and slopes gently toward the shoreline. With the exception of central Key West, most areas are within the 100-year floodplain (ABB, 1995a).

3.3 SURFACE-WATER HYDROLOGY

The surface-water regime in the Florida Keys is dominated by the surrounding saltwater bodies, the Atlantic Ocean and the Gulf of Mexico. The Florida Department of Environmental Protection (FDEP) classifies surface water in the Florida Keys as Class G-III Waters - Recreational, Propagation and Management of Fish and Wildlife. In the immediate area of NAS Key West are the Great White Heron National Wildlife Refuge and the Key West National Wildlife Refuge, which FDEP classifies as Outstanding Florida Waters and which receive the highest degree of protection by the State. These waters are of exceptional recreational and ecological significance to the residents of Florida (ABB, 1995a).

Freshwater recharge in the lower Keys occurs directly through rainfall. The nearly flat topography and porous nature of exposed limestone allows much of the rainfall to infiltrate to shallow groundwater tables, forming freshwater lenses. Remaining rainfall is carried to tidal waters by overland flow or storm drains in most of the more developed areas. Accelerated runoff and increased saltwater intrusion from canals, housing, dewatering (as a mosquito control measure), and marinas decrease the freshwater lens on the Florida Keys, shorten the period that residents can draw on freshwater supplies, and affect water quality. During the dry season, freshwater tends to disappear quickly by seepage to the sea and evaporation. Evaporation exerts an important effect on the Florida Keys' hydrologic budget, with transpiration affecting a more localized and confined area on individual islands (ABB, 1995a).

3.4 GEOLOGY AND SOIL

3.4.1 Geology of the Lower Florida Keys

The lower Keys, which are within the southern or distal geomorphic division of Florida, were formed during the Pleistocene era. Commonly referred to as the "Oolite Keys," they are underlain by the Oolitic Member (Miami Oolite) of the Miami Limestone. The Oolitic Member consists of variably sandy, fossiliferous limestone composed primarily of ooids (spherical calcareous grains 0.25 to 2.0 mm in diameter) that were created through eustatic elevation of the limestone. In the lower Keys, the Oolitic Member consists of the Ooid Calcarenite and the Oomoldic-recrystalline lithofacies. The Ooid Calcarenite lithofacies consists of very fine to coarse sand-size, spherical carbonate grains concentrically laminated around a silt size to fine sand size nucleus. The Oomoldic-recrystalline lithofacies consists of slightly sandy to very sandy well- to moderately well-consolidated micritic calcite. The Miami Oolite conformably overlies the Key Largo Limestone, a geologic unit consisting of light gray to light yellow coralline limestone comprised of coral heads encased in a matrix of calcarenite.

According to ABB, Hoffmeister reported that the Miami Oolite is 27 feet thick. In addition, the Key Largo limestone is greater than 270 feet thick in the western portion of Key West. Figure 3-1 shows a geologic cross-section of the Florida Keys (ABB, 1995a).

3.4.2 Soils

Undisturbed soil in the Keys consists of shallow marl over limestone with the substrate rock outcropping at the surface. Many areas of the Florida Keys, such as Fleming Key, have been filled and graded. The soils on Boca Chica Key are primarily rockland with some filled areas and mangrove swamps. Other major soil groups on Boca Chica Key are Uthorthents, which consist of gravely sand and marl, and Cudjoe, which consists of marl and weathered bedrock (ABB, 1995a). Figure 3-2 is a general soils map of Boca Chica Key.

3.5 HYDROGEOLOGY

3.5.1 Hydrogeology and Water Quality of the Surficial Aquifer

The surficial aquifer system that occurs in the lower Keys consists of the Oolitic Member, which is very porous and highly permeable due to the dissolution of carbonate by groundwater as it recharges the aquifer system. The aquifer is tidally controlled and fluctuates constantly. It is extremely porous, and solution holes and caverns are ubiquitous. The Tamiami Formation lies below the Key Largo Limestone unit, between 300 and 900 feet below land surface (bls). The formation contains mineralized water that does not meet Florida drinking water standards. Underlying the Tamiami Formation are the Hawthorn and Tampa Formations, which together act as an aquiclude confining the underlying limestone units. Below the confining units of the Hawthorn and Tampa Formations is the Suwannee Limestone, a fossiliferous limestone representing the top of the water-producing zone in the Florida Keys. The water is of adequate quality for drinking after treatment. The Avon Park Limestone is 1,300 feet bls and, although it has a higher transmissivity than the Suwannee Limestone and supplies large quantities of drinking water in central Florida, the quality of water from this formation is poor in the Florida Keys (ABB, 1995a).

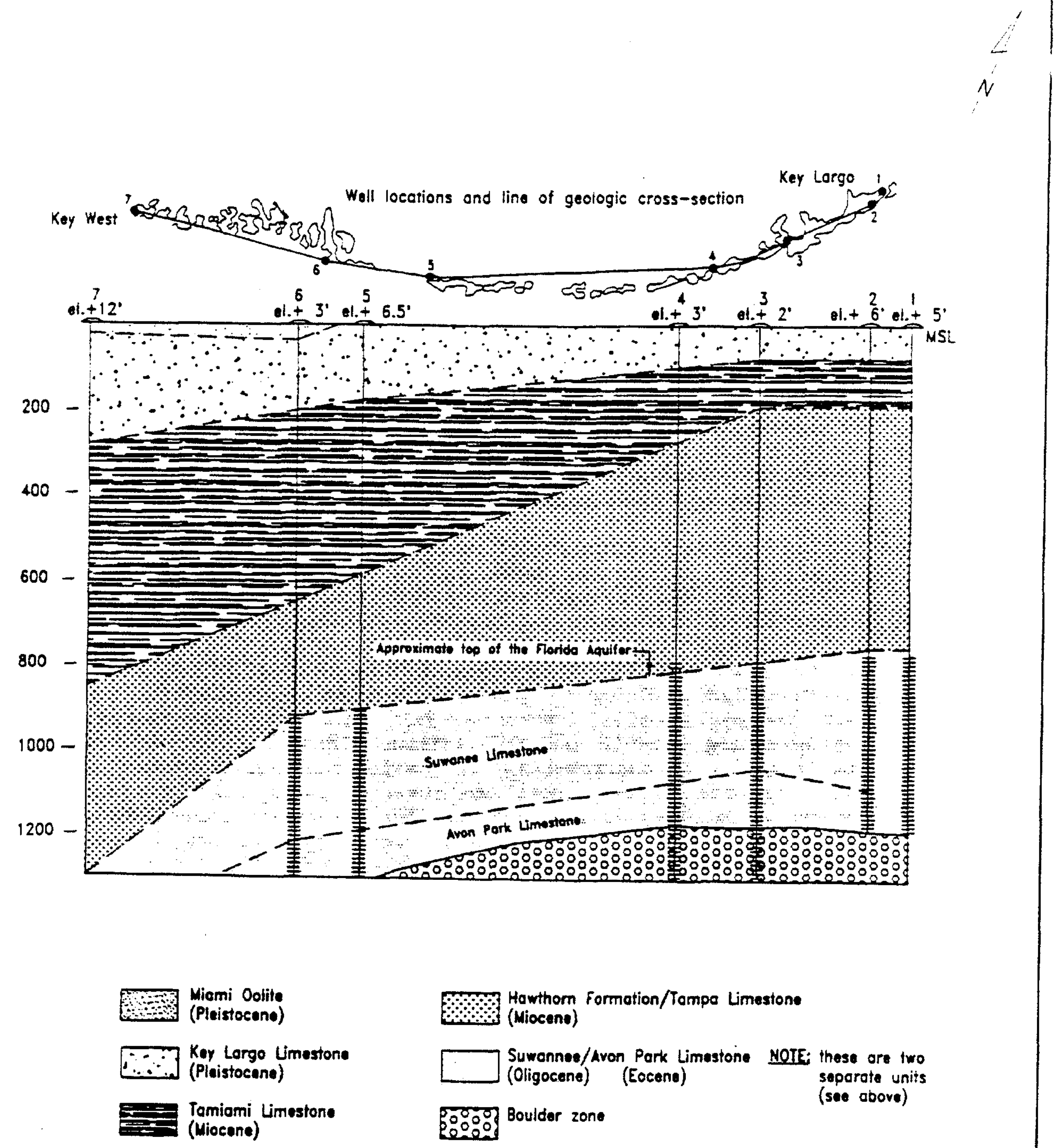


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FIGURE 3-1. GEOLOGIC CROSS-SECTION OF THE FLORIDA KEYS

NAS KEY WEST | KEY WEST, FLORIDA

DRAWN BY: MDB	SCALE: -	DATE: 08/23/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: 7046-5\F3-1GEO8.CDR	

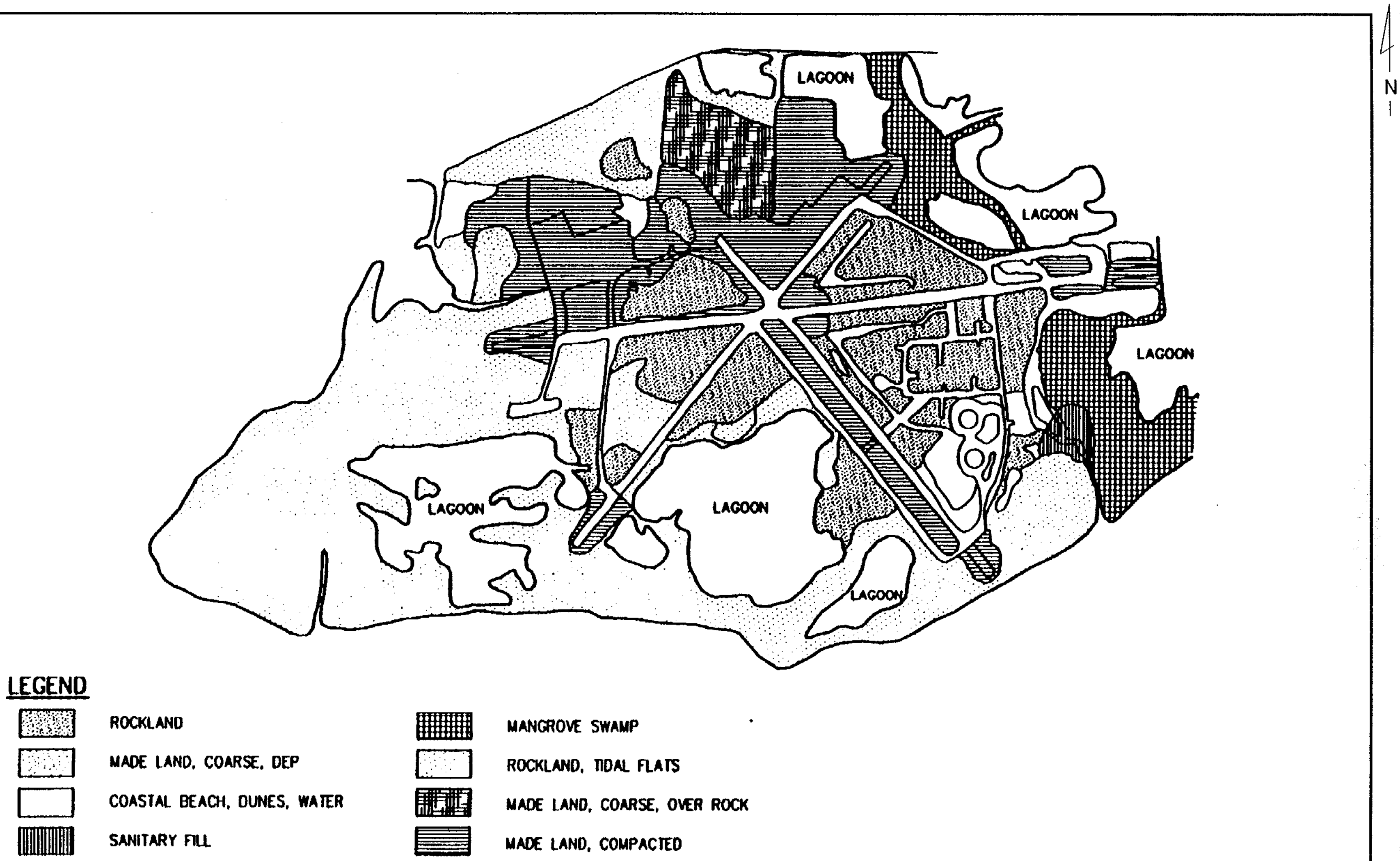

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FIGURE 3-2. GENERAL SOILS MAP
BOCA CHICA KEY

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY: MDB	SCALE: -	DATE: 08/23/96	REV: 0
CHECKED BY: RML	CONTRACT NO.: -	FILE NAME: 7046-3\F3-2GSL8.CDR	

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3.5.2 Groundwater

The unconfined surficial aquifer consists of the highly permeable, porous, solution-riddled Miami Oolite, which allows recharge from rainfall to seep quickly to the ocean and saltwater to intrude easily to the aquifer. The surficial aquifer is the principal aquifer of concern in Key West because of its use as a potable water resource to a limited extent (although not at NAS Key West) and because it is a groundwater-to-surface-water contaminant migration route. The water table ranges in depths from 0.8 to 2.4 feet below msl at the center of Key West and from 0.4 to 2.2 feet below msl near the coast. The water table fluctuates diurnally because of tidal effects. Head differentials associated with tidal variations near the shore can further accelerate groundwater movement in the area. A reconnaissance water-quality sampling study completed in 1990 by the U.S. Geological Survey in cooperation with the South Florida Water Management District indicates that the freshwater lens contains nonpotable water (ABB, 1995a). The State of Florida classifies groundwater in unconfined aquifers that have a total dissolved solids content of 10,000 milligrams per liter (mg/L) or greater as Class G-III (nonpotable water). There are no freshwater public or registered domestic wells on NAS Key West (ABB, 1995a); however, surficial aquifer wells are reportedly in use by domestic residences on Boca Chica and Key West for nonpotable uses such as flushing water. Two residences on Boca Chica Key are reported to use groundwater for non-potable purposes. These residences are approximately 800 feet southeast of Solid Waste Management Unit (SWMU) 1. The City Engineer of Key West also reports that water from some of these types of wells might be used for drinking after such treatment as reverse osmosis. The freshwater lens averages 5 feet in thickness below the center of the western half of Key West. The lens contains between 20 and 30 million gallons of fresh water, depending on the season. Underlying the freshwater lens is a 40-foot transition zone of brackish water (ABB, 1995a).

3.6 POTABLE WATER SUPPLY

Potable water is supplied to all the Florida Keys by the Florida Keys Aqueduct Authority (FKAA). The water is drawn from wells near Florida City in southeastern Dade County and pumped 130 miles through a water main that parallels U.S. Highway No. 1 and terminates in Key West. Water is distributed along the length of the main. In 1984, the FKAA supplied the City of Key West with an average flow of 11.7 million gallons per day (mgd). The Navy received 14.35 percent of the average flow (ABB, 1995a). In some instances, potable water is also obtained by rainwater catchment (the only source prior to the construction of the pipeline in the 1940s).

Alternative sources of potable and nonpotable water used in the Florida Keys include private cisterns, private wells, home desalination systems, and bottled water. The Monroe County Health Department recognizes the public water supply as the only potable water source available on Key West. In addition to managing the centralized public water supply system, the FKAA has the authority to regulate all potable water supplies in the Keys, including alternative sources of water such as those mentioned above. Those residences using a dual system of private and public water are required to use a reduced-pressure valve to prevent water from back-flowing into the water supply system. Private wells in the freshwater lens in the Surficial Aquifer are used for potable and nonpotable water. The number of people who use water from wells in Key West for drinking or non-potable domestic purposes is unknown. The best estimate of the number of people using local groundwater for domestic purposes is less than 500 people (IT Corporation, 1994).

3.7 POPULATION AND LAND USE

The City of Key West, which is the county seat of Monroe County, has a residential population of 24,832 (USCBS, 1990). The principal industry is tourism with about 1,225,000 tourists visiting annually. The Monroe County population (USCBS, 1990) is 78,024, and the average age is approximately 39 years. The average household size is 2.30 persons. The median cost of housing is $164,000. Key West has five elementary schools, two parochial elementary schools, one public high school, the Florida Keys Community College, and May Sands Exceptional Center. There are 33 churches, one synagogue, and two Florida Health System Hospitals (east and west) in Monroe County. Land use in the City of Key West consists primarily of commercial and residential areas. Boca Chica is almost totally a military-use area.

3.8 ECOLOGY

The NAS Key West complex includes areas that are completely developed, areas that are dominated by exotic species such as Brazilian pepper (*Schinus terebinthifolius*) and Australian pine (*Casuarina equisetifolia*), and areas of relatively undisturbed vegetation. The vegetation at NAS Key West can be classified into five natural community types (FNAI, 1994); each of these is described below. Because of the minimal topographic relief in the study area, the boundaries of these natural communities are often areas of gradual change rather than distinct boundaries.

3.8.1 <u>Natural Communities</u>

3.8.1.1 Mangrove Swamp

Approximately 75 percent of the natural communities at NAS Key West can be classified as mangrove swamp, also known as tidal swamp (FNAI, 1994). These areas are dominated by four plant species, red mangrove (*Rhizophora mangle*), black mangrove (*Avidennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erecta*). The relative abundance of each species varies greatly from area to area. The density, average height, degree of canopy closure, and diversity of associated herbaceous species also vary from site to site. Extremes in variation include hyposaline, shallow marl sites supporting 0.5 to 1.5-meters (m)-tall "spider" red mangroves; hypersaline dwarf black mangrove associations; and euryhaline tidal areas on deep peat soils supporting well-developed mixed assemblages of red/black/white mangroves with closed canopies 10 to 12 m tall and trees with diameters of 20 centimeters (cm) at breast height (FNAI, 1994).

Most of the mangrove vegetation at NAS Key West falls well between these extremes. The classic zonation of red mangrove to black mangrove to white mangrove to buttonwood along a seaward to landward elevational and salinity gradient is evident in some areas, but absent at others. The majority of mangrove swamps at NAS Key West are mixed mosaics of mangrove species that vary continuously over a given area with regard to dominance.

Many terrestrial and aquatic vertebrate species are associated with mangrove swamp habitats. At least 220 species of fishes, 24 reptile and amphibian species, 18 mammal species, and 181 bird species (guilds include 18 wading birds, 25 probing shore birds, 29 floating and diving water birds, 14 aerially searching birds, 20 birds of prey, and 71 arboreal birds) inhabit mangrove swamp habitats in Florida (Myers and Ewel, 1990).

An extensive mangrove swamp exists along the eastern edge of SWMU 1. A narrow fringe of mangrove swamp habitat occurs along the water's edge at SWMUs 2, 3, and 9.

3.8.1.2 Coastal Rock Barren

An estimated 8 to 10 percent of the natural vegetation at NAS Key West can be classified as coastal rock barren (FNAI, 1994). Coastal rock barrens are generally characterized as flat rocklands with much exposed and eroded limestone, sparsely vegetated with stunted, xeric, and halophytic shrubs, cacti, algae, and herbs. This community is often dominated by buttonwood in some form. It can vary from bonsai-like sprawling shrubs less than 30 cm in height growing with two or three other stunted halophytes on essentially bare rock pavement to erect, multi-trunked 10-m-tall trees growing on deeper marls and associated with a rich variety of xerophytic shrubs, trees, cacti, graminoids, and forbs. Typical species include saffron plum (*Bumelia celastrina*), Christmas berry (*Lycium carolinana*), cat's claw (*Pithecellobium keyense*), erithalis (*Erithalis fruticosa*), bay cedar (*Suriana maritima*), indigo berry (*Randia aculeata*), wild dilly (*Manilkara bahamensis*), poisonwood (*Metopium toxiferum*), seagrape (*Coccoloba uvifera*), joewood

(*Jacquinia keyensis*), rhacoma (*Crossopetalum rhacoma*), Spanish stopper (*Eugenia myrtoides*), saltgrass (*Distichlis spicata*), fimbristylis (*Fimbristylis castanea*), and Porter's broom spurge (*Chamaesyce porteriana var. scoparia*). In these sites, the coastal rock barren becomes a relatively dense thorn scrub thicket of sclerophyllous vegetation that typically includes epiphytic bromeliads and orchids.

At NAS Key West, coastal rock barren occurs in both the open pavement rockland form and in the deeper marl thicket form. A wide range of forms of this community type at NAS Key West support populations of various vascular plants and vertebrates.

Remnants of this habitat existed at SWMU 2 before the interim remediation conducted in the Spring of 1996. As a consequence, this habitat is currently characterized as upland/filled.

3.8.1.3 Rockland Hammock

Rockland hammocks are small patches of closed, broad-leaved forests that contain a large number of evergreen and semievergreen tropical tree species. These hammocks occupy elevated, rarely inundated areas. An estimated 10 percent of the natural vegetation on NAS Key West is occupied by rockland hammock (FNAI, 1994). Rockland hammock exhibits considerable variation in floristics, structural attributes, and relative dominance in canopy and understory composition. The rockland hammocks of the lower Keys are generally two layered forests with a discontinuous emergent canopy of deciduous species and a continuous evergreen canopy. There is no well-defined subcanopy shrub layer or ground flora. Rockland hammock at NAS Key West generally has a discontinuous emergent layer consisting of dry-season deciduous species such as Jamaica dogwood (*Piscidia piscipula*), poisonwood, or gumbo-lumbo (*Bursera simaruba*). The evergreen continuous canopy layer typically consists of blolly (*Pisonia discolor*), pigeon plum (*Coccoloba diversifolia*), Spanish stopper, white stopper (*Eugenia exillaris*), black ironwood (*Krugiodendron ferrum*), willow bustic (*Dipholis salicifolia*), darling plum (*Reynosia septentrionalis*), wild dilly, brittle thatch palm (*Thrinax morrisii*), torchwood (*Amyris elemifera*), and inkbark (*Exothea paniculata*) (FNAI, 1994).

Rockland hammock offers prime foraging areas for white-crowned pigeon and many wintering and migratory passerines. During the spring and summer, hammocks provide foraging and nesting habitat for black-whiskered vireos and mangrove cuckoos. Hammocks and hammock edges are generally good habitat throughout the year for most of the terrestrial herpetofauna of the lower Keys (FNAI, 1994).

This habitat does not exist at the SWMUs under investigation in this study.

3.8.1.4 Coastal Berm

Several plant communities that can be classified as coastal berm occur on NAS Key West. Approximately 4 percent of the natural plant communities can be classified as coastal berm (FNAI, 1994). Most typically, it occurs along the edges of shallow lagoons and consists of a low shell and marl ridge supporting plant species such as joewood, bay cedar, erithalis, seven-year apple (*Casasia clausiifolia*), sea ox-eye daisy (*Borrichia sp.*), sea grape, and saltgrass, among others (FNAI, 1994).

Another form of the coastal berm community at NAS Key West consists of deep storm-deposited marl and shell ridges integrated into the coastal rock barren community. Typically, these small patches of coastal berm appear as low ridges or hummocks covering the rocky pavement. They support a wide variety of xeric thorn scrub species, particularly saffron plum, cat's claw, poisonwood, buttonwood, sea grape, joewood, prickly pear cactus (*Opuntia stricta*), fimbristylis, and cordgrass (*Spartina spartinae*). These marl/shell deposits support a wide variety of other species, depending on the degree of arboreal development and the actual size of the patch (FNAI, 1994).

As habitat for vertebrates, coastal berm provides suitable foraging habitat for wintering and migratory birds. During periods of spring high tides, coastal berm situated along lagoons is foraging or short-term roosting habitat for a variety of wading birds. This lagoon edge community is used extensively by raccoons (*Procyon lotor*) for foraging.

This habitat does not exist at the SWMUs under investigation in this study.

3.8.1.5 Beach Dune

Less than 1 percent of NAS Key West consists of a sandy beach association that can be classified as beach dune (FNAI, 1994). None of these areas have well-developed dunes or dune vegetation. These communities provide potential habitat, albeit of poor quality, for nesting sea turtles and as seasonal foraging areas for several wading bird species. The limited size of these beach areas at NAS Key West, however, makes it probable that vertebrates populations using them will be small.

This habitat does not exist at the SWMUs under investigation in this study, but narrow beach dunes occur along Boca Chica Road immediately south of SWMU 1.

3.8.2 Wildlife

As expected, wildlife species at NAS Key West vary considerably depending on the habitat. In developed areas of the base, wildlife species are limited primarily to birds that are associated with urbanized areas. On the other hand, a variety of species use the relatively undisturbed habitats (particularly mangrove swamps and lagoons).

An 11-month field study (FNAI, 1994) observed 126 species of birds at NAS Key West. As many as 300 species of birds might use habitats on the base either as migrants or as residents (Schuetz, 1996). Brown and Root Environmental (B&R Environmental) biologists have observed several species of ducks and wading birds in lagoons during the present study.

Four snake and three lizard species were observed during the 11-month FNAI study (FNAI, 1994); the black racer (*Coluber constrictor*), red rat snake (*Elaphe guttata guttata*), Eastern diamondback rattlesnake (*Crotalus adamanteus*), rough green snake (*Opheodrys aestivus*), Florida Keys mole skink (*Eumeces egregius egregius*), Carolina anole (*Anolis carolinensis*), and brown Cuban anole (*A. sagrei*). The endangered Eastern indigo snake (*Drymarchon corais couperi*) has been observed previously (FNAI, 1994); this and other reptiles and amphibians undoubtedly occur on the base.

Very few mammal species occur on NAS Key West and in the lower Florida Keys. Only three native mammal species were observed during the Florida Natural Areas Inventory (FNAI) study (FNAI, 1994); the Lower Keys marsh rabbit, the raccoon, and the opossum (*Didelphis virginianus*). Raccoons are abundant and widespread on the base and opossums are uncommon.

The low species diversity of mammals is presumably due to the relatively harsh natural ecological conditions in the Keys (i.e., poor soils, scarcity of fresh water). In addition, natural habitats have been extensively altered or destroyed by humans, so remaining natural habitats occur in small isolated patches. The invasion of exotic species such as Australian pine has also significantly altered many natural areas.

Few mammal species exist in the Key West area. Carnivorous mammals at NAS Key West are limited to raccoons and feral cats. There are no moles and shrews on the base, and few rodent species occur there. Neither the eastern harvest mouse (*Reithrodontomys humulis*) nor the cotton mouse (*Peromyscus gossypinus*), both common in most of Florida, occur on the base. Native terrestrial mammals on the base appear to be limited to raccoons, marsh rabbits, opossums, and possibly cotton rats (*Sigmodon hispidus*). Silver rice rats (*Oryzomys argentatus*) have been recorded on Saddlebunch Key, but not on Boca Chica Key, in spite of extensive trapping efforts (FNAI, 1994). Three exotic rodents also occur on the base; the

Norway rat (*Rattus norvegicus),* black rat (*Rattus rattus*), and house mouse (*Mus musculus*) (Frank, 1996; Schuetz, 1996).

3.8.3 Water Quality and Fish

3.8.3.1 SWMU 1

Water quality measurements and fish samples were taken at three small (approximately 40 to 80 feet long by 15 feet wide by 2 to 3 feet deep) ponds (water-filled borrow pits) in the mangrove swamp just east of the excavated portion of SWMU 1. The water in the ponds was turbid and coffee-colored, and the pond bottoms were dark organic muck. When field personnel waded through the ponds, disturbing the bottom sediments, the odor of fuel oil was strong. The water in the ponds was brackish, with salinities ranging from 23.7 parts per thousand (ppt) to 24.0 ppt during the January 24, 1996, visit. On the basis of these salinity measurements, the ponds would be characterized as "mixohaline," or more specifically "mixo-polyhaline," according to the classification system of Reid (1961). For comparison, the salinity of sea water is normally around 35 ppt, and the salinity of most inland (surface) waters ranges from 0.1 to 1.0 ppt (Reid, 1961; Wetzel, 1983). Conductivity measurements at this location ranged from 37.3 to 37.5 millisiemens per centimeter (mS/cm); as expected, conductivity was closely related to salinity.

Dissolved oxygen measured 0.5 mg/L at the southernmost SWMU 1 pond on January 24, 1996, too low to support most fish and aquatic life. Odum et al. (1982) notes that surface water associated with mangroves is characteristically turbid, dark colored (stained with organic acids and tannins), and low in dissolved oxygen. Mangrove ecosystems tend to act as nutrient (especially nitrogen and phosphorus) sinks and consumers of oxygen. Odum et al. suggests that nutrients are removed and oxygen consumed by a combination of organic detritus on the surface of sediments, the fine root systems of mangroves, small invertebrates, and bacteria and fungi on all these surfaces. As a result, dissolved oxygen concentrations in mangroves are often "below saturation, typically 2 to 4 ppm (mg/L) and...near zero in stagnant locations."

Based on January 1996 fish sampling, the SWMU 1 ponds support healthy populations of several small, hardy fish species [e.g., sheepshead minnow (*Cyprinodon variegatus*), sailfin molly (*Poecilia latipinna*), crested goby (*Lophogobius cyprinoides*), and fat sleeper (*Dormitator maculatus*)] that are able to tolerate high water temperatures and low dissolved oxygen levels. All four fish species are characteristic of south Florida tidal creeks and mangrove swamps (Odum et al., 1982).

Odum et al. (1982) describes isolated mangrove wetlands (seasonally flooded pools, similar to those at SWMU 1) as particularly harsh environments "which few species of fishes can tolerate." Dissolved oxygen concentrations are frequently low (1 to 2 mg/L) in these wetlands, and hydrogen sulfide levels can be high. The fish families best adapted to this kind of habitat are the euryhaline cyprinodonts (killifishes, including the sheepshead minnow) and the poecilids (livebearers, including the sailfin molly). While the species richness of fishes in these isolated mangrove wetlands is low, the densities of fish are often surprisingly high (Odum et al., 1982).

3.8.3.2 SWMU 2

Water quality measurements and fish samples at SWMU 2 were taken from a ditch that is approximately 500 feet long and a 15-acre lagoon at the east end of the ditch. Water temperatures in the ditch, which was 3 to 4 feet deep, approximately 12 feet wide, and overgrown with mangroves, ranged from 21.1 degrees Centigrade (°C) to 23.8°C. Dissolved oxygen concentrations ranged from 2.0 to 2.35 mg/L at the time of the site visit. As noted above, dissolved oxygen concentrations in waters flowing though mangroves are often low, particularly in areas like the ditch at SWMU 2 where there is limited water circulation. There was a distinct odor of fuel oil/petroleum in the bottom sediments of the ditch. Although the water temperature in the adjoining lagoon was comparable (23.2°C), the dissolved oxygen concentration was much higher, 7.3 mg/L. This was probably due to wind-induced mixing and aeration of water in the open waters of the lagoon and (to a lesser degree) photosynthetic oxygen production.

Salinities ranging from 9.2 to 9.6 ppt in the SWMU 2 ditch were closely related to specific conductance. Specific conductance and salinity in the lagoon were slightly lower, 15.0 mS/cm and 8.7 ppt, respectively. Three of four pH readings in the ditch at SWMU 2 were 7.4 or higher, while one was considerably lower at 6.5. This anomalous pH measurement is difficult to explain and may be the result of an instrument malfunction or a transcription error. Dissolved oxygen levels in the ditch at SWMU 2 were low in January 1996, ranging from 2.0 to 2.35 mg/L, which is generally too low to support a balanced biological community of aquatic organisms. However, the ditch contained numerous large mullet, tarpon, and ladyfish, all of which appeared to be healthy and well nourished. Fish are able to move freely between the ditch and the adjoining lagoon, and thus can move into the lagoon when temperatures in the ditch are too high or oxygen levels too low.

3.8.3.3 SWMU 3

The 16-acre lagoon at SWMU 3 does not have a direct outlet to the Atlantic Ocean but almost certainly receives water from the ocean as a result of infrequent wind-generated (storm) tides. This lagoon, like the lagoon at SWMU 2, can be classified as mesohaline (mixo-mesohaline), with salinities ranging from 7.1 ppt to 8.4 ppt. Dissolved oxygen concentrations showed considerable variation from area to area within the lagoon, ranging from 2.1 mg/L to 7.58 mg/L. Dissolved oxygen levels were highest in shallow, sunlit weedy areas and lowest in shaded mangrove areas, suggesting that photosynthetic oxygen production contributed to the higher levels. Fish collected at this location were generally hardy minnow-like species such as sailfin molly and sheepshead minnow, probably because the lagoon is shallow (approximately 2 feet deep) and unshaded and would be subject to high water temperatures in most months of the year. The only exception was a juvenile American eel caught in a minnow trap. Several days of gill netting produced no larger fish, and none were seen by field personnel in the clear shallow water of the lagoon.

3.8.3.4 SWMU 9

SWMU 9, the only sampling location with a direct connection to open ocean (the Gulf of Mexico), had a salinity measurement of 26.0 ppt ("mixo-polyhaline") and a corresponding specific conductance of 41.0 mS/cm. Water temperatures varied little from sampling location to location (21.0 to 22.0°C) and dissolved oxygen concentrations ranged from 4.1 to 4.9 mg/L. These dissolved oxygen levels are sufficient to support a balanced community of aquatic organisms. Mangrove (flat tree) oysters were abundant at this location and were collected in lieu of fish because fish are able to move freely in and out of the area and are less likely to be affected by activities at the SWMU 9 jet engine test cell.

3.8.4 Endangered and Threatened Species

Tables 3-1 and 3-2 list Federal and state-listed endangered and threatened species recorded at NAS Key West (FNAI, 1994). A few listed species not recorded on the Tables 3-1 and 3-2 lists undoubtedly occur on the base but have not been reported to FNAI. For example, several listed sea turtle species occasionally use beaches in the Key West area (IT Corporation, 1994). The Florida tree snail (*Liguus fasciatus*), listed as a Species of Special Concern (SSC) by the Florida Game and Fresh Water Fish Commission (FGFWFC), the Stock Island tree snail (*Orthalicus reses*) listed as endangered by the FGFWFC and threatened by the United States Fish and Wildlife Service (FWS), and the mangrove rivulus (*Rivulus marmoratus*), listed as a SSC by FGFWFC, might occur in the area (Deyrup and Franz, 1994; Gilbert, 1992).

TABLE 3-1

ENDANGERED AND THREATENED ANIMAL SPECIES KNOWN TO OCCUR AT NAS KEY WEST (FNAI, 1994) NAS KEY WEST

Common Name	Scientific Name	Designated Status	
		FGFWFC	US FWS
Fish			
Key silverside	*Menidia conchorum*	T	-
Reptiles			
Eastern indigo snake	*Drymarchon corais couperi*	T	T
Red rat snake	*Elaphe guttata guttata*	SSC	-
Florida Keys mole skink	*Eumeces egregius egregius*	SSC	-
Birds			
White crowned pigeon	*Columba leucocephala*	T	-
Little blue heron	*Egretta caerulea*	SSC	-
Reddish egret	*Egretta rufescens*	SSC	-
Snowy egret	*Egretta thula*	SSC	-
Tricolored heron	*Egretta tricolor*	SSC	-
White ibis	*Eudocimus albus*	SSC	-
Bald eagle	*Haliaeetus leucocephalus*	T	T
Osprey	*Pandion haliaetus*	SSC	-
Brown pelican	*Pelecanus occidentalis*	SSC	-
Least tern	*Sterna antillarum*	T	-
Roseate tern	*Sterna dougallii*	T	T
Mammals			
Silver rice rat	*Oryzomys argentatus*	E	E
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*	E	E
Florida manatee	*Trichechus manatus*	E	E

Notes: E = Endangered.
T = Threatened.
SSC = Species of special concern.
- = Not Listed.
FGFWFC = Florida Game and Fresh Water Fish Commission.
US FWS = U.S. Fish and Wildlife Service.

TABLE 3-2

ENDANGERED AND THREATENED PLANT SPECIES KNOWN TO OCCUR AT NAS KEY WEST (FNAI, 1994) NAS KEY WEST

Common Name	Scientific Name	Designated Status	
		FDA	US FWS
Blodgett's wild mercury	*Argythamnia blodgettii*	E	-
Locustberry	*Byrsonima Lucida*	E	-
Porter's spurge	*Chamaesyce porteriana*	E	-
Geiger tree	*Cordia sebestena*	E	-
Rhacoma	*Crossopetalum rhacoma*	E	-
Wild cotton	*Gossypium hirsutum*	E	-
Manchineel	*Hippomane mancinella*	E	-
Joewood	*Jacquinia keyensis*	T	-
Bahama brake	*Pteris bahamensis*	E	-
West Indies mahogany	*Swietenia mahogani*	E	-
Brittle thatch palm	*Thrinax morrissi*	E	-
Florida thatch palm	*Thrinax radiata*	E	-
Banded wild pine	*Tillandsia flexuosa*	E	-
Worm-vine orchid	*Vanilla barbellata*	E	-

Notes: E = Endangered.
T = Threatened.
- = Not Listed.
FDA = Florida Department of Agriculture and Consumer Services.
US FWS = U.S. Fish and Wildlife Service.

B&R Environmental biologists observed several listed species during the present study. For example, an active bald eagle nest was observed approximately 0.5 mile southwest of SWMU 2. Wading birds, including little blue herons, snowy egrets, tricolored herons, reddish egrets, and white ibis were observed foraging in lagoons and ditches. Ospreys were commonly observed, and three nesting pairs have been recorded on the base (FNAI, 1994). White crowned pigeons were commonly observed in flight at various locations. The Lower Keys marsh rabbit is known to occur near SWMU 1 and SWMU 2.

4.0 SOLID WASTE MANAGEMENT UNITS

4.1 SWMU 1 - BOCA CHICA OPEN DISPOSAL AREA

This section describes the site-specific evaluation of data for Solid Waste Management Unit (SWMU) 1. It discusses previous investigations conducted at the site, Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) rationale, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, baseline human health risk assessment, and ecological risk assessment. Section 4.1.9 presents recommendations for SWMU 1.

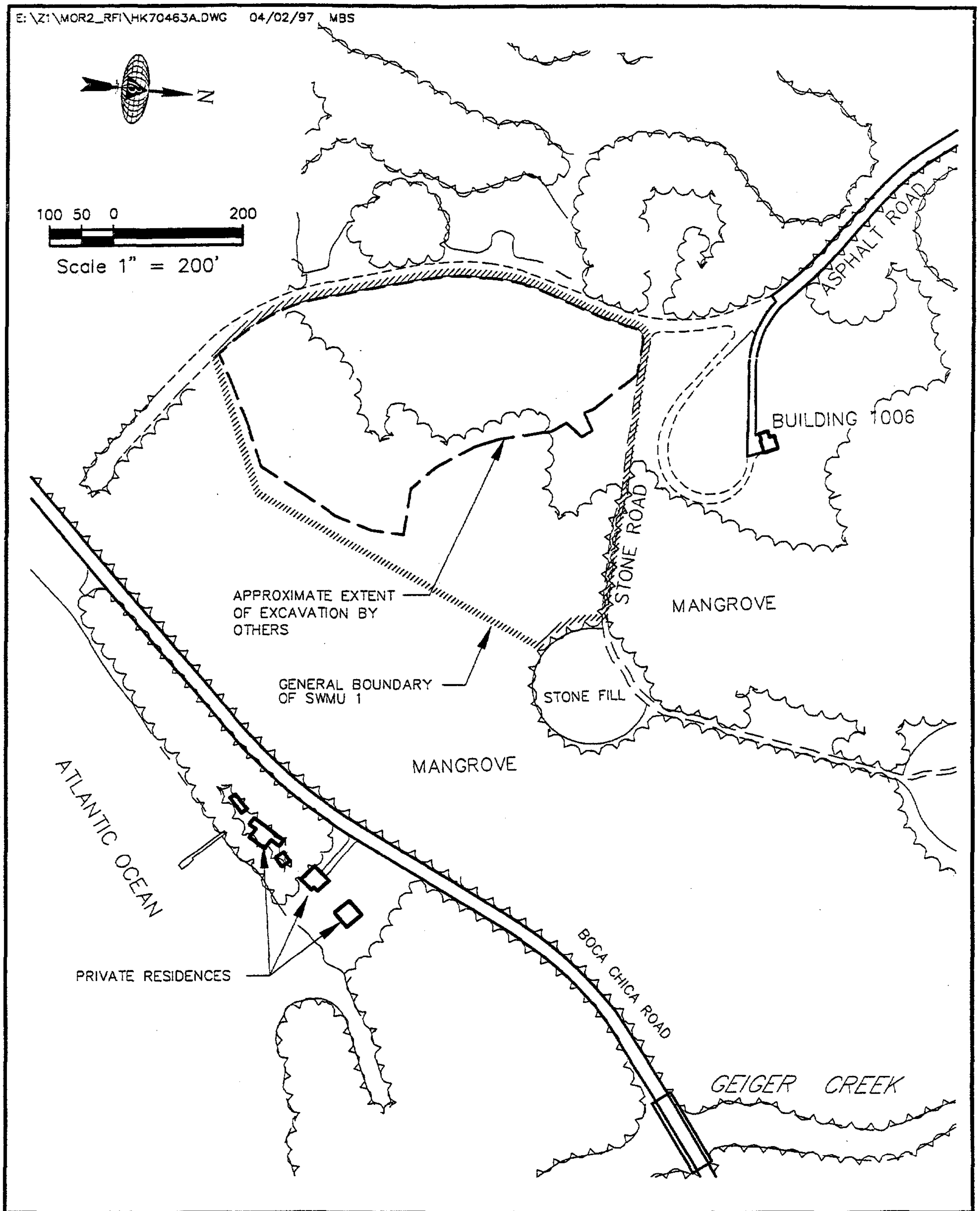
4.1.1 Unit Description

This site, designated as Site No. 4 in the 1987 Geraghty and Miller Study and the 1991 RI, consists of a former open disposal and burning area in the southeastern part of Boca Chica Key, between Stone Road and the mangrove swamp fringing Geiger Creek and the Atlantic Ocean as shown in Figure 4-1. It was operated from 1942, when the Naval Air Station (NAS) activity was established on Boca Chica, until the mid-1960s. SWMU 1 reportedly received general refuse and waste associated with aircraft maintenance activities. The list of possible wastes it received includes waste oil, hydraulic fluid, paint thinner, and solvents. An estimated 2,600 tons of waste were disposed of or burned each year. Three abandoned aboveground fuel storage tanks were in the northwestern part of the site. The area of waste disposal and burning (approximately 4 acres) is indicated by debris present near the eastern edges of the site.

SWMU 1 is relatively flat with low vegetation and mangroves along its perimeter. Shell and gravel roads along the edge of the site enabled access to remote antenna sites that are no longer in use, although the site is adjacent to an operating communications center. The south and east sides of SWMU 1 are bordered closely by the Atlantic Ocean. It is not unusual for much of the unit to be under water during and after rainfall events. The site slopes gradually toward the mangrove swamp that lies between the site and the ocean shoreline. Sediments that originate from erosion of the site surface are deposited in the mangroves.

4.1.2 Site-Specific Investigations

This section presents a summary of the results from the investigations that have been conducted at SWMU 1 through the Spring of 1996. Previous investigations are considered to be all investigations that



SITE MANAGER: RD	CHECKED BY: KW	Brown & Root Environmental	FIGURE 4-1 **SITE LOCATION MAP SWMU 1** NAVAL AIR STATION BOCA CHICA KEY, FLORIDA
DRAWN BY: TCB	DRAWING DATE: 7/24/96		
SURVEYED BY: TCB	SURVEY DATE: 2/21/96		
SCALE: 1" = 200'			
CAD DWG. NO.: HK70463A	PROJ. NO.: HK7046		

were conducted prior to the Supplemental RFI/RI in January 1996. Current investigations include the Supplemental RFI/RI conducted by Brown & Root (B&R) Environmental and confirmational sampling conducted by Bechtel Environmental, Inc., (BEI) after the interim remedial action that was conducted during the Spring of 1996.

4.1.2.1 Previous Investigations

Section 1.3 summarizes previous investigations at NAS Key West. This section provides more details regarding the investigations conducted before January 1996 at SWMU 1.

4.1.2.1.1 Initial Investigation

In 1986, four shallow groundwater monitoring wells (KWM-05 through KWM-08) were installed by Geraghty and Miller during an initial investigation to depths of 10 to 12 feet at the perimeter of the burn area. The analytical results listed the range of total dissolved solids from 24,000 to 42,000 parts per million (ppm). Acid extractables, pesticides, and polychlorinated biphenyls (PCBs) were not detected above analytical method detection limits in these samples. Several volatile organic compounds (VOCs) were detected in concentrations at or below 16 parts per billion (ppb); total xylenes were detected at 35 ppb. In addition, several base-neutral extractable compounds were detected in concentrations of less than 10 micrograms per liter (µg/L). Naphthalene was detected at 34 µg/L in one groundwater sample. Of the metals analyzed, concentrations of mercury (65 µg/L), copper (60 µg/L), and arsenic (10 µg/L) were above detection limits.

4.1.2.1.2 Preliminary Remedial Investigation

In 1990, IT Corporation conducted a Preliminary RI at the site that included the installation of five monitoring wells (MW4-1 through MW4-5) and sampling of the groundwater, soil, surface water, and sediment. Analysis for VOCs in the selected media was conducted under both Appendix IX and Target Compound List (TCL) analysis. VOCs in soil and sediment samples were not found above the project-specific action limits. Polynuclear aromatic hydrocarbons (PAHs) were found in one sediment sample. In addition, VOCs were not detected in any surface-water samples, but 1,2-dichloroethene (DCE) was detected in one groundwater sample slightly above the action limits. Metals were detected in some surface or groundwater samples. Aroclor-1260, dichlorodiphenyl dichloroethane (DDD), dichlorodiphenyl trichloroethane (DDT), dichlorodiphenyl dichloroethylene (DDE), and heptachlor epoxide were detected in soil samples, but only concentrations of heptachlor epoxide and Aroclor-1260 were significant. Sediment samples contained levels of aldrin and heptachlor.

4.1.2.1.3 RCRA Facility Investigation/Remedial Investigation

IT Corporation conducted an RFI/RI at SWMU 1 in 1993 which included the installation of two new monitoring wells (S1MW-1 and S1MW-2). The RFI/RI report (IT Corporation, 1994) concluded that the waste handling performed on the site, including burning and open disposal, caused impacts to the environment. Both organic and inorganic chemicals were present in samples collected from groundwater, surface water, soil, and sediments. Groundwater samples contained antimony, chrysene, cyanide, lead, mercury, and vinyl chloride at concentrations exceeding standards. Hence, these chemicals were designated as chemicals of concern (COC) at SWMU 1. The monitoring wells at the north end of SWMU 1 did not contain compounds at concentrations greater than the standards. The report also concluded that there are no human health risks above the level of concern, although human health risks could occur if the groundwater is used as a potable water source.

Soil samples S1SB-3, S1SB-4, and S1SB-5 contained chemicals at concentrations greater than background levels. Only the sample collected at S1SB-4, however, contained concentrations exceeding the standards for more than one compound. A sample collected from S1SB-3 contained lead in the Toxicity Characteristic Leaching Procedure (TCLP) extract at 19,600 μg/L. This concentration of lead indicated that the soils in this area would be classified as hazardous waste.

Copper, lead, mercury, and zinc concentrations in the surface-water sample collected at S1SS-1 exceeded the standards. Sediment samples collected at S1SS-1, S1SS-2, and S1SS-3 contained chemicals of potential concern (COPC) above background. Several pesticides, PAHs, and metals exceeded the standards for sediment and were classified as COCs.

4.1.2.1.4 Delineation Sampling

In 1995, BEI performed delineation sampling on a staggered 50-foot grid pattern (BEI, 1995a). Lead exceeded the sediment quality cleanup criteria at many of the sampling locations. However, a TCLP analysis found that three samples containing the highest levels of lead would not be classified as hazardous waste.

4.1.2.2 Current Investigations

The scope of the Supplemental RFI/RI at SWMU 1 is summarized in Section 4.1.3.1. In addition to the results from the Supplemental RFI/RI, additional data was obtained from the confirmational sampling conducted by BEI after the interim remedial action in February and March of 1996. This data was accepted and used in the analyses for SWMU 1 to provide comprehensive analysis of data for making decisions about SWMU 1. Data from the confirmational sampling were not validated, which adds some conservatism to the analyses performed.

4.1.3 RCRA Facility Investigation Rationale

This section presents the reasons for conducting the Supplemental RFI/RI activities at SWMU 1. Section 4.1.3.1 discusses the scope of the field work performed in January 1996; Section 4.1.3.2 discusses the analytical parameters.

4.1.3.1 Scope of Field Investigation

Supplemental field activities at SWMU 1 included surface soil sampling to characterize background conditions, surface-water and sediment sampling to delineate further the contaminants detected in earlier activities, the installation of four monitoring wells (S1MW-3 through S1MW-6), and groundwater sampling to characterize background conditions and verify previously detected contamination. Because the site adjoins wetland areas and previous work had sufficiently characterized surface soil in the disposal area, the investigation restricted soil sampling to off-site, noninundated areas that required characterization along the boundary of the disposal area for use in background comparison. Part of this requirement was satisfied during the delineation sampling (BEI, 1995a).

Surface-water and sediment samples were collected along the disposal area perimeter where the extent of contamination had not been sufficiently delineated, particularly within the mangroves to the south-southeast of the main disposal area. Some of the surface-water and sediment sampling was performed during the delineation sampling, but additional locations were proposed to satisfy RFI/RI program objectives.

Groundwater sampling was conducted to characterize background (hydraulically upgradient) groundwater quality and areas hydraulically downgradient as necessary, particularly with respect to lead, mercury, cyanide, vinyl chloride, and chrysene. A monitoring well hydraulically upgradient from the site was installed to characterize background groundwater quality.

4.1.3.2 Analytical Parameters

All SWMU surface soil, sediment, and tissue samples were analyzed for the following parameters:

- Appendix IX Organics [VOCs, semivolatile organic compounds (SVOCs), pesticides, and PCBs]
- Target Analyte List (TAL) metals
- Cyanide

In addition, the SWMU 1 groundwater samples were analyzed for the following parameters:

- Appendix IX VOCs and SVOCs
- TAL metals
- Cyanide

4.1.4 Geology and Hydrogeology

The regional geology and hydrogeology of the Florida Keys are presented in Sections 3.4 and 3.5. The site-specific geology and hydrogeology of SWMU 1 were determined from soil borings and monitoring wells installed during the Preliminary RI, the RFI/FI, and the Supplemental RFI/RI.

4.1.4.1 Geology and Soils

The material encountered during the soil borings and the installation of the monitoring wells consisted of fill overlying natural oolitic limestone. At SWMU 1, the fill material was encountered at the ground surface and ranged to 8 feet below land surface (bls). Specifically, the fill material was composed of sand and gravel mixed with silt, reworked crushed oolitic limestone, and shell fragments. Natural oolitic limestone and limestone/sand mixtures encountered below the fill continued to boring termination in all monitoring wells. The standard penetration test (SPT) blow counts recorded during soil boring shows that the limestone beneath the fill is of medium density.

Geotechnical data were obtained from a composite soil sample collected during the Preliminary RI. This sample was collected from MW4-1 at 0 to 2 feet bls. Geotechnical data included grain size distribution, moisture content, soil pH, cation exchange capacity, total organic carbon (TOC) content, and permeability. Grain size analysis indicates the soil is a poorly sorted medium- to coarse-grained sandy gravel with fines. The soil has a pH of 7.50 and a cation exchange capacity of 35.74 milliequivalents per gram (meq/g), indicating the medium has a relatively low ability to capture and retain cations. The TOC value of

1.04 milligrams per kilogram (mg/kg) indicates minimal organic matter to attenuate contaminants. The permeability value of the soil is 2.29E-06 centimeters per second (cm/sec), which is representative of low-permeability materials.

4.1.4.2 Hydrogeology

Fifteen monitoring wells have been installed at SWMU 1 (see Figure 4-2). Four wells were installed during the Initial Investigation, five wells during the Preliminary RI, two wells during the RFI/RI, and four wells during the Supplemental RFI/RI. The monitoring well installation and construction logs for the Supplemental RFI/RI wells are included in Appendix I (Boring Logs) and Appendix K (Field Data Forms). The indigenous material encountered below SWMU 1 consists of compacted fill overlaying oolitic limestone. The Preliminary RI reports that oolitic limestone is expected to have hydraulic conductivity values at the higher end of the range from 72 gallons per day per square foot (gpd/ft^2) to 1,024 gpd/ft^2, whereas the compacted fill is expected to represent the lower end of the stated values.

During the 1993 RFI/RI, IT Corporation indicated that the direction of groundwater flow was from the west of the unit toward the mangroves, Geiger Creek, and the Atlantic Ocean to the east of the unit. The hydraulic gradient of groundwater flow at SWMU 1 was 0.0009 feet per foot (ft/ft). The groundwater flow direction was consistent throughout the 5-week monitoring period of groundwater elevations for the unit. Groundwater elevation data collected during the Preliminary RI in August 1990 depict the groundwater flow direction to be consistent with that presented in the 1993 RFI/RI. Groundwater level measurements collected on January 30, 1996, were generally consistent with the easterly flow previously observed. Groundwater levels are generally a foot bls. The average groundwater elevations shown in Figure 4-2 indicate the groundwater flow observed at the unit.

The Preliminary RI determined that ocean tides influence groundwater levels at the site. During the RFI/RI, pressure transducers were attached to data logging devices and installed at monitoring wells KWM-7 and MW4-5 to monitor hourly changes in groundwater levels due to tidal fluctuations. A comparison of groundwater-level fluctuations with actual sea-level fluctuations obtained from the tide tables indicated a time lag of three hours between the water level fluctuations at the well closest to the shoreline (KWM-7) and the inshore well (MW4-5). This time lag for fluctuations to travel a distance of 900 feet is indicative of a highly transmissive hydrogeologic environment. Although the groundwater at the site is tidally influenced, no ambiguity was determined in the direction of groundwater flow (from monitoring during the Preliminary RI and RFI/RI), which was observed to flow from the unit toward the ocean.

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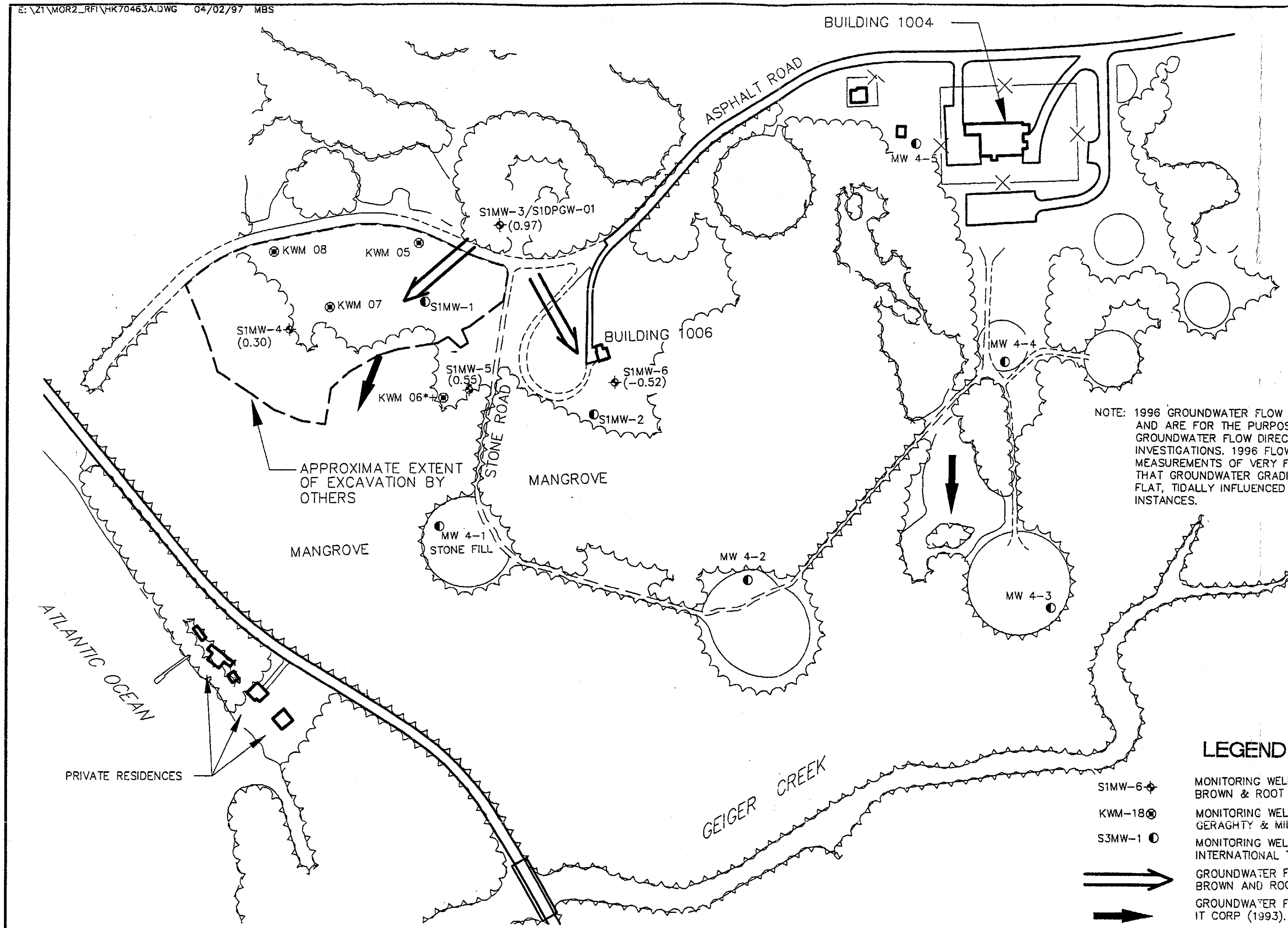


NOTE: 1996 GROUNDWATER FLOW DIRECTIONS ARE APPROXIMATE AND ARE FOR THE PURPOSE OF GENERAL COMPARISON WITH PAST GROUNDWATER FLOW DIRECTIONS REPORTED BY PREVIOUS INVESTIGATIONS. 1996 FLOW DIRECTIONS ARE BASED ON ONE-TIME MEASUREMENTS OF VERY FEW WELLS. IT SHOULD ALSO BE NOTED THAT GROUNDWATER GRADIENTS AT NAS KEY WEST ARE EXTREMELY FLAT, TIDALLY INFLUENCED AND PROBABLY RADIAL IN SOME INSTANCES.

LEGEND

S1MW-6	MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
KWM-18	MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)
S3MW-1	MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
	GROUNDWATER FLOW DIRECTION OBSERVED BY BROWN AND ROOT ENVIRONMENTAL (1996).
	GROUNDWATER FLOW DIRECTION OBSERVED BY IT CORP (1993).
(0.97)	GROUNDWATER ELEVATION (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB	DRAWING DATE: 3/1/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 200'	
CAD DWG. NO.: HK70463A	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-2

GROUNDWATER FLOW AND ELEVATIONS SWMU 1

NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.1.5 Nature and Extent of Contamination

The nature and extent of contamination were investigated by analyzing samples from soil, sediment, surface water, and groundwater in the vicinity of the Open Disposal Area. The results of these analyses were compared with applicable or relevant and appropriate requirements (ARARs) or screening action levels (SALs) that were most restrictive for a given chemical in the given media, listed in Section 2.3.1.

This section focuses primarily on chemicals that exceeded the most conservative ARAR/SAL criteria. The discussion is accompanied by figures which show the concentrations of certain contaminants of interest (COIs). The COIs were selected based on the criteria presented in Appendix G, Section 3.1.3.2. Appendix L contains the analytical results for samples obtained during the January 1996 Supplemental RFI.

4.1.5.1 Soil

Chemicals that were detected in surface and subsurface soil samples are listed in Tables 4-1 and 4-2. These tables include analytical results from historical sampling and the Supplemental RFI/RI. The results from duplicate samples are averaged in Table 4-2. Semivolatiles and metals accounted for most of the chemicals found in the soil at the Open Disposal Area. In general, metals were found throughout the site, while semivolatiles were limited to the northeastern and southwestern portions. Figure 4-3 shows the occurrence of compounds that exceeded ARARs or SALs and indicated soil contamination. Data from a number of sampling efforts, including the 1995 BEI delineation study, the 1996 BEI confirmatory study, the 1990 IT Corporation RI, the 1993 IT Corporation RFI/RI, and this 1996 Supplemental RFI/RI, were considered in the analysis of contamination at SWMU 1. The bulk of the data came from BEI and from sampling associated with this Supplemental RFI/RI. However, most of the BEI soil samples, those from south of the Stone Road and in the vicinity of the excavated area on Figure 4-3, were tested only for lead. These were also the only locations where subsurface soil was analyzed. Sediment samples were used to obtain a more complete characterization of contamination in this region of the site.

To be conservative, contaminant levels discussed in this section were compared to the most restrictive criteria from several sets of ARARs and SALs, including Oak Ridge National Lab (ORNL) Benchmark Toxicity Values (BTVs), U.S. Environmental Protection Agency (EPA) Region III Biotechnical Assistance Group (BTAG) BTVs, proposed RCRA Subpart S Action Levels, Residential/Preliminary Remediation Goals (RPRGs), Florida Department of Environmental Protection (FDEP) Residential Cleanup Goals, and FDEP Industrial Soil Cleanup Goals. For reference, these criteria are presented in Table 2-3.

TABLE 4-1

**CONTAMINANTS DETECTED IN SUBSURFACE SOIL AT SWMU 1
NAS KEY WEST**

Location	Date	Parameter	Result	Qual.[1]
METALS (mg/kg)				
M-14	07/26/95	Lead	688	EN
N-14	07/26/95	Lead	247	EN
U-14	07/26/95	Lead	172	EN
P-14	07/26/95	Lead	141	EN
N13	07/29/95	Lead	73.2	
U-15	07/26/95	Lead	71.5	EN
P-15	07/27/95	Lead	61.1	EN
R-13	07/26/95	Lead	24.3	EN
P-13	07/26/95	Lead	23.3	EN
R-14	07/26/95	Lead	18.2	EN
P-12	07/26/95	Lead	11.5	EN
S-14	07/26/95	Lead	6.7	EN
S-15	07/27/95	Lead	6.2	EN
S-15	07/27/95	Lead	5	EN
L-16	07/26/95	Lead	0.92	EN

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST
PAGE 1 OF 6

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S1SS-7	01/13/96	Aluminum	7,810	
S1SS-5	01/13/96	Aluminum	5,815	
S1SS-6	01/13/96	Aluminum	4,160	
V16	07/27/95	Aluminum	3,170	E
U19	07/27/95	Aluminum	2,970	E
S1SB-5	05/93	Aluminum	2,760	
H25	07/29/95	Aluminum	1,540	
S1SS-7	01/13/96	Antimony	21.7	
V16	07/27/95	Antimony	3.1	B
H25	07/29/95	Antimony	2.3	B
U19	07/27/95	Antimony	1.3	B
MW4-5	09/19/90	Arsenic	6.4	
S1SB-5	05/93	Arsenic	3.3	
V16	07/27/95	Arsenic	2.4	*
U19	07/27/95	Arsenic	1.5	*
H25	07/29/95	Arsenic	1.2	B
S1SS-7	01/13/96	Barium	99.6	
S1SS-5	01/13/96	Barium	40.3	
V16	07/27/95	Barium	28.2	E
S1SS-6	01/13/96	Barium	21.7	
H25	07/29/95	Barium	17.7	B
S1SB-5	05/93	Barium	14.4	B
U19	07/27/95	Barium	13.6	BE
MW4-5	09/19/90	Barium	9.7	B
V16	07/27/95	Beryllium	0.2	B
U19	07/27/95	Beryllium	0.15	B
H25	07/29/95	Beryllium	0.13	B
S1SS-7	01/13/96	Cadmium	11.2	
S1SS-6	01/13/96	Cadmium	4.3	
V16	07/27/95	Cadmium	3.5	EN*
S1SS-5	01/13/96	Cadmium	2.8	
H25	07/29/95	Cadmium	1.85	
U19	07/27/95	Cadmium	0.96	EN*
H25	07/29/95	Calcium	362,000	
V16	07/27/95	Calcium	342,000	
U19	07/27/95	Calcium	340,000	
S1SS-6	01/13/96	Calcium	330,000	
S1SS-7	01/13/96	Calcium	321,000	
S1SS-5	01/13/96	Calcium	305,000	
S1SB-5	05/93	Calcium	255,000	
S1SS-7	01/13/96	Chromium	184	
S1SS-5	01/13/96	Chromium	18.8	
V16	07/27/95	Chromium	14.6	E*
U19	07/27/95	Chromium	10.7	E*
S1SS-6	01/13/96	Chromium	10	
MW4-5	09/19/90	Chromium	9.7	
H25	07/29/95	Chromium	8	
S1SB-5	05/93	Chromium	7.5	
S1SS-7	01/13/96	Cobalt	4.6	
S1SS-5	01/13/96	Cobalt	1.8	
V16	07/27/95	Cobalt	1.2	B
S1SS-6	01/13/96	Cobalt	0.53	
U19	07/27/95	Cobalt	0.47	B
H25	07/29/95	Cobalt	0.45	B
S1SS-7	01/13/96	Copper	407	
V16	07/27/95	Copper	128	*
S1SS-5	01/13/96	Copper	112	

TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST
PAGE 2 OF 6

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S1SS-6	01/13/96	Copper	38	
U19	07/27/95	Copper	33.6	*
MW4-5	09.19/90	Copper	26.8	
H25	07/29/95	Copper	16	
S1SB-5	05/93	Copper	4.3	
S1SS-7	01/13/96	Iron	28,500	
S1SS-5	01/13/96	Iron	15,200	
V16	07/27/95	Iron	5,910	E*
S1SS-6	01/13/96	Iron	2,180	
U19	07/27/95	Iron	2,030	E*
H25	07/29/95	Iron	1,980	
S1SB-5	05/93	Iron	1,900	
M-14	07/26/95	Lead	740	EN
R-14	07/26/95	Lead	500	EN
L17	03/96	Lead	436	E
I15	03/96	Lead	407	E
S1SS-7	01/13/96	Lead	381	
U-15	07/26/95	Lead	281	EN
N-14	07/26/95	Lead	273	EN
M18	03/96	Lead	236	E
S-15	07/27/95	Lead	225	EN
L-15	07/26/95	Lead	204	EN
S1SS-5	01/13/96	Lead	196	
H15	03/96	Lead	193	E
R-16	07/25/95	Lead	176	EN
V16	07/27/95	Lead	165	E*
P-14	07/26/95	Lead	160	EN
P22	03/96	Lead	147	EN
S-14	07/26/95	Lead	141	EN
U-14	07/26/95	Lead	131	EN
K15	03/96	Lead	131	E
T21	03/96	Lead	129	EN
E18	03/96	Lead	124	E
N-13	07/26/95	Lead	113	EN
F17	03/96	Lead	105	E
F20	03/96	Lead	97	E
U19	07/27/95	Lead	91.9	E*
S1SS-6	01/13/96	Lead	84.6	
P-13	07/26/95	Lead	65	EN
R-13	07/26/95	Lead	57.1	EN
G16	03/96	Lead	55	E
E19	03/96	Lead	54	E
S19	03/96	Lead	38	
P-12	07/26/95	Lead	35.1	EN
T22	03/96	Lead	32	EN
M23	03/96	Lead	31	EN
MW4-5	09/19/90	Lead	27.1	
P19	03/96	Lead	20	
S-19	07/25/95	Lead	19.1	EN
K23	03/96	Lead	18	EN
H25	07/29/95	Lead	16.3	
R22	03/96	Lead	15	EN
S-17	07/27/95	Lead	14.6	EN
I14	03/96	Lead	13	
J14	03/96	Lead	12	
P18	03/96	Lead	10	EN
S20	03/96	Lead	10	EN

TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
I22	03/96	Lead	9.5	E
S22	03/96	Lead	8	EN
R-18	07/25/95	Lead	7.7	EN
S1SB-5	05/93	Lead	5.2	
L-16	07/26/95	Lead	3.8	EN
G21	03/96	Lead	3	E
J15	03/96	Lead	3	E
M-15	07/26/95	Lead	2.2	EN
P-15	07/27/95	Lead	0.47	EN
S1SB-5	05/93	Magnesium	16,000	
S1SS-6	01/13/96	Magnesium	12,200	
S1SS-7	01/13/96	Magnesium	12,100	
V16	07/27/95	Magnesium	8,330	E
S1SS-5	01/13/96	Magnesium	6,900	
H25	07/29/95	Magnesium	4,140	
U19	07/27/95	Magnesium	3,680	E
S1SS-7	01/13/96	Manganese	467	
S1SS-5	01/13/96	Manganese	124	
V16	07/27/95	Manganese	60	E*
S1SS-6	01/13/96	Manganese	35.1	
S1SB-5	05/93	Manganese	23	
U19	07/27/95	Manganese	21.7	E*
H25	07/29/95	Manganese	19.1	
S1SS-7	01/13/96	Mercury	6.2	
V16	07/27/95	Mercury	0.25	
H25	07/29/95	Mercury	0.25	
MW4-5	09/19/90	Mercury	0.15	
S1SS-5	01/13/96	Mercury	0.14	

Location	Date	Parameter	Result	Qual.(1)
U19	07/27/95	Mercury	0.12	
S1SS-7	01/13/96	Nickel	50.2	
S1SS-5	01/13/96	Nickel	11.3	
V16	07/27/95	Nickel	9.8	
H25	07/29/95	Nickel	6.45	
MW4-5	09/19/90	Nickel	5.9	B
U19	07/27/95	Nickel	3.7	B
S1SS-6	01/13/96	Nickel	3.3	
V16	07/27/95	Potassium	785	
U19	07/27/95	Potassium	619	
S1SS-7	01/13/96	Potassium	614	
S1SS-6	01/13/96	Potassium	501	
H25	07/29/95	Potassium	333	B
S1SS-5	01/13/96	Potassium	257	
S1SB-5	05/93	Potassium	248	B
V16	07/27/95	Selenium	0.61	B
U19	07/27/95	Selenium	0.51	
H25	07/29/95	Selenium	0.24	B
S1SS-7	01/13/96	Silver	7.6	
V16	07/27/95	Silver	3.9	
H25	07/29/95	Silver	3.9	
S1SS-5	01/13/96	Silver	3.15	
S1SS-6	01/13/96	Silver	1.5	
U19	07/27/95	Silver	0.58	B
S1SS-7	01/13/96	Sodium	5,770	
V16	07/27/95	Sodium	5,240	
U19	07/27/95	Sodium	4,890	
H25	07/29/95	Sodium	2,800	
S1SS-6	01/13/96	Sodium	2,110	

TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST
PAGE 4 OF 6

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S1SB-5	05/93	Sodium	1,850	
S1SS-5	01/13/96	Sodium	889	
V16	07/27/95	Tin	11.8	B
H25	07/29/95	Tin	9.6	B
MW4-5	09/19/90	Tin	6.1	
U19	07/27/95	Tin	3.6	B
S1SS-5	01/13/96	Vanadium	11.1	
MW4-5	09/19/90	Vanadium	9.1	
S1SS-7	01/13/96	Vanadium	7.4	
V16	07/27/95	Vanadium	7	
S1SS-6	01/13/96	Vanadium	6.8	
U19	07/27/95	Vanadium	4.8	B
S1SB-5	05/93	Vanadium	4.4	B
H25	07/29/95	Vanadium	3.35	B
S1SS-5	01/13/96	Zinc	870	
S1SS-7	01/13/96	Zinc	783	
V16	07/27/95	Zinc	321	EN
U19	07/27/95	Zinc	173	EN
S1SS-6	01/13/96	Zinc	120	
H25	07/29/95	Zinc	66	
MW4-5	09/19/90	Zinc	53.8	
S1SB-5	05/93	Zinc	15.8	
PESTICIDES/PCBs (µg/kg)				
V16	07/27/95	4,4'-DDD	1,400	
S1SS-7	01/13/96	4,4'-DDE	1,730	
V16	07/27/95	4,4'-DDE	430	J
H25	07/29/95	4,4'-DDE	15.6	
V16	07/27/95	4,4'-DDT	4,700	
S1SS-7	01/13/96	4,4'-DDT	709	
U19	07/27/95	4,4'-DDT	68	P
H25	07/29/95	4,4'-DDT	5.38	P
U19	07/27/95	Aroclor-1260	900	
S1SS-6	01/13/96	Aroclor-1260	644	J
S1SS-6	01/13/96	Endrin	19.7	
U19	07/27/95	Endrin aldehyde	45	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
V16	07/27/95	Acetophenone	120	J
U19	07/27/95	Anthracene	280	J
S1SS-5	01/13/96	Anthracene	257	J
S1SS-5	01/13/96	Benzo(a)anthracene	3,420	J
U19	07/27/95	Benzo(a)anthracene	320	J
H25	07/29/95	Benzo(a)anthracene	270	J
V16	07/27/95	Benzo(a)anthracene	160	J
S1SS-5	01/13/96	Benzo(a)pyrene	2,190	
U19	07/27/95	Benzo(a)pyrene	420	J
H25	07/29/95	Benzo(a)pyrene	265	J
V16	07/27/95	Benzo(a)pyrene	200	J
S1SS-5	01/13/96	Benzo(b)fluoranthene	6,830	
H25	07/29/95	Benzo(b)fluoranthene	440	J
U19	07/27/95	Benzo(b)fluoranthene	330	J
V16	07/27/95	Benzo(b)fluoranthene	270	J
S1SS-5	01/13/96	Benzo(g,h,i)perylene	1,940	
U19	07/27/95	Benzo(g,h,i)perylene	190	J
V16	07/27/95	Benzo(g,h,i)perylene	180	J
H25	07/29/95	Benzo(g,h,i)perylene	180	J
U19	07/27/95	Benzo(k)fluoranthene	410	J
H25	07/29/95	Benzo(k)fluoranthene	225	J

TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg) (cont.)				
V16	07/27/95	Benzo(k)fluoranthene	160	J
S1SB-5	05/93	Bis(2-ethylhexyl)phthalate	2,200	BJ
S1SB-5	05/93	Bis(2-ethylhexyl)phthalate	1,700	J
MW4-5	09/19/90	Bis(2-ethylhexyl)phthalate	550	J
V16	07/27/95	Bis(2-ethylhexyl)phthalate	120	J
S1SS-5	01/13/96	Chrysene	5,440	J
U19	07/27/95	Chrysene	670	J
H25	07/29/95	Chrysene	325	J
V16	07/27/95	Chrysene	240	J
U19	07/27/95	Chrysene	210	J
U19	07/27/95	Di-n-butyl phthalate	230	J
V16	07/27/95	Di-n-butyl phthalate	140	J
H25	07/29/95	Di-n-butyl phthalate	86	J
S1SS-5	01/13/96	Dibenzo(a,h)anthracene	605	
U19	07/27/95	Dibenzo(a,h)anthracene	150	J
V16	07/27/95	Dibenzo(a,h)anthracene	110	J
H25	07/29/95	Dibenzo(a,h)anthracene	84	J
S1SS-5	01/13/96	Fluoranthene	7,100	
U19	07/27/95	Fluoranthene	630	J
H25	07/29/95	Fluoranthene	455	J
V16	07/27/95	Fluoranthene	290	J
U19	07/27/95	Fluoranthene	250	J
U19	07/27/95	Hexachlorophene	890	
H25	07/29/95	Hexachlorophene	770	
V16	07/27/95	Hexachlorophene	670	
S1SS-5	01/13/96	Indeno(1,2,3-cd)pyrene	1,590	
U19	07/27/95	Indeno(1,2,3-cd)pyrene	370	J
V16	07/27/95	Indeno(1,2,3-cd)pyrene	230	J

Location	Date	Parameter	Result	Qual.[1]
H25	07/29/95	Indeno(1,2,3-cd)pyrene	190	J
S1SS-5	01/13/96	Phenanthrene	2,760	
U19	07/27/95	Phenanthrene	300	J
U19	07/27/95	Phenanthrene	280	J
H25	07/29/95	Phenanthrene	195	J
V16	07/27/95	Phenanthrene	120	J
S1SS-5	01/13/96	Pyrene	6,290	J
U19	07/27/95	Pyrene	1,200	J
U19	07/27/95	Pyrene	420	J
H25	07/29/95	Pyrene	405	J
V16	07/27/95	Pyrene	320	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S1SS-6	01/13/96	1,1,2,2-tetrachloroethane	1	J
S1SB-5	05/93	2-butanone	32	
S1SS-6	01/13/96	2-hexanone	1	J
S1SB-5	05/93	Acetone	230	
V16	07/27/95	Acetone	50	
U19	07/27/95	Acetone	49	
S1SB-5	05/93	Acetonitrile	9	J
S1SS-6	01/13/96	Bis(2-chloroisopropyl)ether	6	J
S1SS-6	01/13/96	Chlorodibromomethane	0.44	J
S1SS-5	01/13/96	Ethylbenzene	036	J
S1SS-6	01/13/96	Ethylbenzene	2	J
S1SS-7	01/13/96	Ethylbenzene	0.34	J
S1SB-5	05/93	Methylene chloride	70	B
MW4-5	09/19/90	Methylene chloride	10	
S1SS-6	01/13/96	Toluene	7	
S1SS-7	01/13/96	Toluene	3	
S1SB-5	05/93	Toluene	3	J

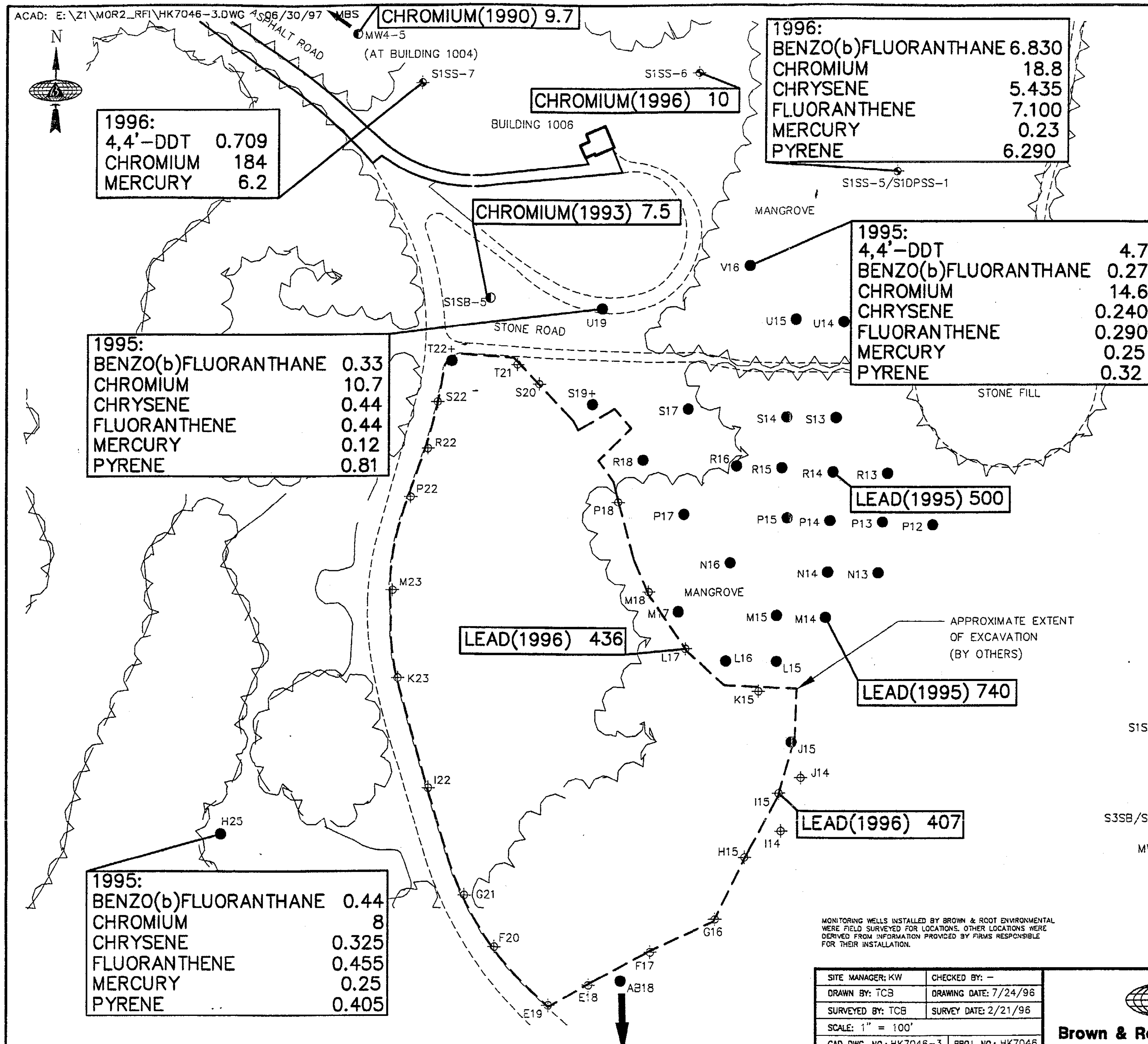
TABLE 4-2

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 1
NAS KEY WEST
PAGE 6 OF 6

Location	Date	Parameter	Result	Qual.[1]
VOLATILE ORGANIC COMPOUNDS (µg/kg) (cont.)				
S1SS-5	01/13/96	Toluene	2	J
S1SS-7	01/13/96	Trans-1,4-dichloro-2-butene	2	J
S1SB-5	05/93	Xylenes (total)	7	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.



PARAMETER	STANDARD~
4,4'-DDT	0.1
BENZO(b)FLUORANTHENE	0.1
CHROMIUM	0.0075
CHRYSENE	0.1
FLUORANTHENE	0.1
LEAD	400
MERCURY	0.1
PYRENE	0.1

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-4.

NOTE: THIS FIGURE INDICATES THE CHEMICALS OF INTEREST AT THIS SITE. OTHER CHEMICALS IN EXCESS OF ARAR's AND SAL's ARE THE FOLLOWING:

4,4'-DDD	BENZO(g,h,i)PERYLENE	TIN
4,4'-DDE	BENZO(k)FLUORANTHENE	ZINC
ALUMINUM	BERYLLIUM	
ANTHRACENE	COPPER	
AROCLOR 1260	DIBENZO(a,h)ANTHRACENE	
ARSENIC	INDENO(1,2,3-CD)PYRENE	
BENZO(a)ANTHRACENE	MANGANESE	
BENZO(a) PYRENE	NICKEL	

NOTE: SEVERAL SUBSURFACE BORINGS WERE TESTED FOR LEAD. THE LEAD CONTENT (688mg/kg) IN SUBSURFACE SOIL FROM 12-24 INCHES WAS THE ONLY INSTANCE WHERE ARAR/SAL CRITERIA WAS EXCEEDED.

LEGEND

- S1SS-7 ⌖ SOIL BORING/SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
- P15 ● SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
- J14 ⌖ SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
- S3SB/SS-1 ◐ SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
- MW4-5 ◐ SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
- \+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996

50 25 0 100
Scale 1" = 100'

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-3	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-3
SURFACE SOIL CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

0090 8037

4.1.5.1.1 Volatile Organic Compounds

No VOCs exceeded the ARAR/SAL criteria in any of the soil samples. A number of VOCs, including 1,1,2,2-tetrachloroethane, 2-hexanone, 2-butanone, acetone, acetonitrile, bis(2-chloroisopropyl)ether, chlorodibromomethane, ethylbenzene, methylene chloride, toluene, trans-1,2-dichloro-2-butene, and xylene were detected at low levels north of the Stone Road. Most of these compounds were found at one of two locations -- S1SS-6, sampled in 1996, or S1SB-5, sampled by IT Corporation in 1993.

4.1.5.1.2 Semivolatile Organic Compounds

Eleven different SVOCs exceeded the ARAR/SAL criteria for soil at the Open Disposal Area. No samples were analyzed for these compounds in the central portion of the site, which was excavated. Of the other sampling locations, the northeastern and southwestern portions of SWMU 1 appeared to be the major areas impacted by SVOC contamination. Although U19 contained all 11 SVOCs that were detected at SWMU 1, the highest SVOC concentrations consistently occurred in S1SS-5/S1DPSS-1, the most northeastern sample. This 1996 sample contained 10 of the 11 SVOCs at the following levels: anthracene at 0.257 mg/kg, benzo(a)anthracene at 3.42 mg/kg, benzo(a)pyrene at 2.19 mg/kg, benzo(b)fluoranthene at 6.830 mg/kg, benzo(g,h,i)perylene at 1.94 mg/kg, chrysene at 5.44 mg/kg, dibenzo(a,h)anthracene at 0.605 mg/kg, fluoranthene at 7.1 mg/kg, indeno(1,2,3-cd)pyrene at 1.59 mg/kg, and pyrene at 6.29 mg/kg. With the exception of anthracene, these SVOCs were also detected in H25 (in the southwest corner of the site) and V16 (near S1SS-5). Benzo(k)flouranthene occurred at both these locations, as well as U19, where it was at its maximum (0.41 mg/kg). Although SVOC concentrations at H25, U19 and V16, all sampled by BEI in 1995, were greater than ARAR/SAL levels, they were generally much lower than those seen at S1SS-5/S1DPSS-1. No significant levels of SVOCs were found in the soil samples from the northwestern part of SWMU 1.

4.1.5.1.3 Pesticides

Samples from the northwest and north-central portions of the site were found to contain pesticide levels in excess of the ARAR/SAL criteria. Soil in the area of V16 and U19 appears to contain the highest pesticide levels with peak values of 4,4'-DDT (4.7 mg/kg) and 4,4'-DDD (1.4 mg/kg) occurring at V16. S1SS-7, the most northwesterly point sampled at SWMU 1, contained 4,4'-DDT and 4,4'-DDE.

4.1.5.1.4 Polychlorinated Biphenyls

Aroclor-1260 was the only PCB detected in soil at SWMU 1. It was found in two samples from the north-central region of the site. The sample from U19 contained the maximum concentration, 0.900 mg/kg, while a concentration of 0.644 mg/kg occurred at S1SS-6, to the north of U19.

4.1.5.1.5 Metals and Inorganics

Metals were detected throughout the site, but S1SS-7, in the northwestern corner, consistently showed the highest concentrations. The maximum detected concentration of aluminum (7,810 mg/kg), copper (407 mg/kg), chromium (184 mg/kg), manganese (467 mg/kg), and mercury (6.2 mg/kg) occurred in this sample. Aluminum, chromium, and nickel are most commonly detected in excess of ARAR/SAL criteria. Each exceeded the most conservative criteria in seven samples. Copper and manganese are equally widespread at the Open Disposal Area, but because concentrations are below the ARAR/SAL criteria in many samples, the predominant concern for these two chemicals is associated with S1SS-7, and, in the northeast corner of the site, at S1SS-5 and V16. Mercury exceeded its ARAR/SAL criteria at S1SS-5 and V-16, and also occurred in the southwestern corner of the site at H25. Peak concentrations of arsenic (3.3 mg/kg), beryllium (0.2 mg/kg), and zinc (870 mg/kg) were detected at S1SB-5, V16, and S1SS-5, respectively. Tin was detected at four locations, with the highest concentration (1.8 mg/kg) occurring at V16. The north-central and west-central portions of the site appear to be the regions that receive the least impacts from metals in the soil; samples from S1SB-5 and S1SS-6 contained the fewest of the compounds discussed here.

Although once a major concern at the Open Disposal Area, lead no longer appears to be a widespread source of metal contamination in the soil. A large number of samples were analyzed for lead, with most of the locations concentrated in the central portion of the site around the excavated area. Sixty-three surface soil samples were tested for lead, and only four were found to contain concentrations in excess of the 400-mg/kg proposed RCRA Subpart S Action Level. The highest lead concentration (740 mg/kg) was found by BEI in a delineation sample (M14) from the central part of the site. This location also contained lead in subsurface soil at a comparable concentration (688 mg/kg). No other subsurface samples contained appreciable concentrations of lead.

4.1.5.2 Sediment

Sediment samples were taken from the interior of the site, between Boca Chica Road and the Stone Road to characterize any contamination in that region. Chemicals that were detected in sediment samples are listed in Table 4-3. This table lists analytical results from historical sampling and the Supplemental RFI/RI. The results from duplicate samples are averaged in Table 4-3. The contaminants found in this area were very similar to those detected in soil samples from the other parts of the Open Disposal Area. Metals were the predominant contaminant detected, although semivolatiles and pesticides were also prevalent. Figure 4-4 shows the contaminants that exceeded ARAR and SAL limits.

To be conservative, contaminant levels discussed in this section were compared to the most restrictive of several sets of ARAR/SAL criteria, including Florida Sediment Quality Guidelines, EPA Region IV Sediment Screening Values, Federal Sediment Quality Criteria, proposed RCRA Action Levels, Effects Range-Low (ER-L) Criteria, Effects Range-Medium (ER-M) Criteria, and EPA Sediment Quality Benchmarks (SQB). Table 2-4 contains these criteria.

4.1.5.2.1 Volatile Organic Compounds

Two VOCs, acetone, and carbon disulfide were found to exceed ARAR/SAL criteria in the sediment at the Open Disposal Area. Acetone was detected in two samples, S1SS-6SD, in the southwestern part of the site, and S1SS-4SD, which is in the northeastern interior portion of the site, about 200 feet west of Boca Chica Road and slightly south of the stone fill area. The maximum amount of acetone, 0.15 mg/kg, was detected at S1SS-6SD, in the same region as H25, the soil sample which contained a number of SVOCs. Carbon disulfide was detected only at S1SS-6SD at 13.5 µg/kg. Other volatiles, including toluene, xylene, tetrachloroethene, methylene chloride, dibromomethane, methyl methacrylate, and chloromethane were also detected at the site, although none were in excess of the ARAR/SAL levels. Low levels of these VOCs were detected more frequently in the samples from S1SD-2, near Boca Chica Road, and S1SS-4SD, where acetone was found.

4.1.5.2.2 Semivolatile Organic Compounds

The highest degree of SVOC contamination was evident at S1SS-1, in the north-central interior portion of the site. Peak values of benzo(a)pyrene (11 mg/kg), chrysene (14 mg/kg), pyrene (18 mg/kg), benzo(g,h,i)perylene (7 mg/kg), and indeno(1,2,3-cd)pyrene (5.9 mg/kg) were all detected in this sample. Although these levels are much higher than those in the soil to the north at V16, the parameters are consistent with those detected in the soil. Sediment SVOC levels elsewhere on the site were lower than those found at S1SS-1. S1SS-6SD contained chrysene, pyrene and benzo(g,h,i)perylene, as well as the maximum sediment levels of benzo(b)fluoranthene (1.37 mg/kg) and fluoranthene (0.52 mg/kg). These concentrations were consistent with those found in soil slightly to the northwest at H25. Several SVOCs

TABLE 4-3

CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 1
NAS KEY WEST
PAGE 1 OF 4

Location	Date	Parameter	Results	Qual.[1]
HERBICIDES (µg/kg)				
S1SD-01	01/22/96	Methyl parathion	35.5	J
INORGANICS (mg/kg)				
S1SS-4SD	07/28/95	Aluminum	2,580	E
S1SS-5SD	07/28/95	Aluminum	2,500	
S1SS-6SD	07/28/95	Aluminum	2,070	E
S1SD-03	01/24/96	Aluminum	2,060	
S-2	05/90	Aluminum	1,990	
S1SD-02	01/22/96	Aluminum	1,650	
S1SD-01	01/22/96	Aluminum	1,040	
S1SS-4SD	07/28/95	Antimony	3	B
S1SS-5SD	07/28/95	Antimony	2.2	B
S1SS-6SD	07/28/95	Antimony	1.1	B
S1SD-03	01/24/96	Arsenic	17.1	
S1SS-3	05/93	Arsenic	7.8	
S1SS-5SD	07/28/95	Arsenic	5.6	B
S1SS-4SD	07/28/95	Arsenic	4.5	B*
S1SS-6SD	07/28/95	Arsenic	3.15	B*
S1SS-3	05/93	Barium	10.3	B
S-2	05/90	Barium	9	B
S1SD-02	01/22/96	Barium	8.4	
S1SS-4SD	07/28/95	Barium	6	BE
S1SD-01	01/22/96	Barium	5.6	
S1SD-03	01/24/96	Barium	5.3	
S1SS-6SD	07/28/95	Barium	5.1	BE
S1SS-5SD	07/28/95	Barium	5	B
S1SS-5SD	07/28/95	Beryllium	0.28	B
S1SS-4SD	07/28/95	Beryllium	0.14	B
S1SS-6SD	07/28/95	Beryllium	0.109	B

Location	Date	Parameter	Results	Qual.[1]
S1SS-6SD	07/28/95	Cadmium	1.8	BEN*
S1SS-5SD	07/28/95	Cadmium	0.43	B
S1SS-4SD	07/28/95	Cadmium	0.41	BEN*
S1SD-02	01/22/96	Cadmium	0.39	
S1SD-02	01/22/96	Calcium	235,000	
S1SD-01	01/22/96	Calcium	174,000	
S1SS-6SD	07/28/95	Calcium	48,200	
S-2	05/90	Calcium	45,100	
S1SS-5SD	07/28/95	Calcium	27,200	
S1SD-03	01/24/96	Calcium	14,500	
S1SS-4SD	07/28/95	Calcium	12,000	
S1SS-3	05/93	Chromium	23.8	
S-2	05/90	Chromium	15	
S1SD-03	01/24/96	Chromium	11.5	
S1SS-5SD	07/28/95	Chromium	10.4	
S1SS-4SD	07/28/95	Chromium	8.7	E*
S1SS-6SD	07/28/95	Chromium	7.6	E*
S1SD-02	01/22/96	Chromium	6.1	
S1SD-01	01/22/96	Chromium	4.2	
S1SS-3	05/93	Copper	430	
S-2	05/90	Copper	211	
S1SS-6SD	07/28/95	Copper	50.5	*
S1SD-03	01/24/96	Copper	42.1	
S1SD-01	01/22/96	Copper	39.5	
S1SS-4SD	07/28/95	Copper	21.8	*
S1SS-5SD	07/28/95	Copper	12.3	B
S1SD-02	01/22/96	Copper	3.3	
S1SD-03	01/24/96	Cyanide	3.8	J
S1SS-6SD	07/28/95	Iron	2,395	E*

TABLE 4-3

CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 1
NAS KEY WEST
PAGE 2 OF 4

Location	Date	Parameter	Results	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S1SD-03	01/24/96	Iron	1,160	
S1SS-5SD	07/28/95	Iron	825	
S-2	05/90	Iron	794	
S1SS-4SD	07/28/95	Iron	782	E*
S1SD-01	01/22/96	Iron	735	
S1SD-02	01/22/96	Iron	608	
S1SS-3	05/93	Lead	327	
S-2	05/90	Lead	73.3	
S1SD-03	01/24/96	Lead	52.1	
S1SS-6SD	07/28/95	Lead	39.8	E*
S1SS-4SD	07/28/95	Lead	28.7	E*
S1SS-5SD	07/28/95	Lead	19.3	
S1SD-01	01/22/96	Lead	15	
S1SD-02	01/22/96	Lead	10.4	
S1SD-03	01/24/96	Magnesium	18,300	
S1SS-4SD	07/28/95	Magnesium	15,000	E
S1SS-6SD	07/28/95	Magnesium	13,900	E
S1SS-5SD	07/28/95	Magnesium	13,500	
S-2	05/90	Magnesium	11,200	
S1SD-02	01/22/96	Magnesium	8,430	
S1SD-01	01/22/96	Magnesium	4,820	
S1SD-02	01/22/96	Manganese	6.5	
S1SS-5SD	07/28/95	Manganese	6.4	B
S1SD-01	01/22/96	Manganese	6.2	
S1SS-6SD	07/28/95	Manganese	6.1	BE*
S-2	05/90	Manganese	4.6	B
S1SD-03	01/24/96	Manganese	4.3	
S1SS-4SD	07/28/95	Manganese	4.1	BE*

Location	Date	Parameter	Results	Qual.(1)
S1SS-3	05/93	Mercury	1.9	
S-2	05/90	Mercury	0.4	
S1SS-4SD	07/28/95	Mercury	0.31	B
S1SS-6SD	07/28/95	Mercury	0.31	
S1SS-3	05/93	Nickel	14.3	B
S1SD-03	01/24/96	Nickel	6.2	
S1SS-6SD	07/28/95	Nickel	4.05	B
S1SS-4SD	07/28/95	Nickel	3	B
S1SD-01	01/22/96	Nickel	2	
S1SD-02	01/22/96	Nickel	1.9	
S1SS-5SD	07/28/95	Nickel	1.8	B
S1SD-03	01/24/96	Potassium	5,150	
S1SS-4SD	07/28/95	Potassium	4,660	
S1SS-6SD	07/28/95	Potassium	4,200	
S1SS-5SD	07/28/95	Potassium	3,790	
S1SD-02	01/22/96	Potassium	2,200	
S1SD-01	01/22/96	Potassium	1,060	
S1SS-4SD	07/28/95	Selenium	3.4	
S1SS-6SD	07/28/95	Selenium	2.8	B
S1SS-3	05/93	Selenium	1.2	B
S1SS-3	05/93	Silver	3.5	B
S1SD-03	01/24/96	Sodium	108,000	
S1SS-6SD	07/28/95	Sodium	91,200	
S1SS-4SD	07/28/95	Sodium	88,700	
S-2	05/90	Sodium	75,700	
S1SS-5SD	07/28/95	Sodium	64,700	
S1SD-02	01/22/96	Sodium	41,200	
S1SD-01	01/22/96	Sodium	16,800	
S1SS-3	05/93	Tin	72.4	B

TABLE 4-3

CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 1
NAS KEY WEST
PAGE 3 OF 4

Location	Date	Parameter	Results	Qual.[1]
INORGANICS (mg/kg) (cont.)				
S1SS-5SD	07/28/95	Tin	12.1	B
S1SS-4SD	07/28/95	Tin	8.9	B
S1SS-6SD	07/28/95	Tin	8.6	B
S1SS-3	05/93	Vanadium	33.4	
S1SD-03	01/24/96	Vanadium	31	
S1SS-5SD	07/28/95	Vanadium	26.4	B
S1SS-4SD	07/28/95	Vanadium	25.1	B
S1SS-6SD	07/28/95	Vanadium	13.3	B
S-2	05/90	Vanadium	9.4	B
S1SD-02	01/22/96	Vanadium	6.6	
S1SD-01	01/22/96	Vanadium	1.9	
S1SS-3	05/93	Zinc	168	
S1SS-6SD	07/28/95	Zinc	131	EN
S-2	05/90	Zinc	119	
S1SD-03	01/24/96	Zinc	51.8	
S1SD-01	01/22/96	Zinc	39.9	
S1SS-4SD	07/28/95	Zinc	27.9	EN
S1SD-02	01/22/96	Zinc	25.1	
S1SS-5SD	07/28/95	Zinc	19.8	E
PESTICIDES/PCBs (µg/kg)				
S1SS-1	05/93	4,4'-DDD	210	C
S1SS-3	05/93	4,4'-DDD	71	C
S1SS-6SD	07/28/95	4,4'-DDD	28	P
S1SS-3	05/93	4,4'-DDE	110	C
S1SS-6SD	07/28/95	4,4'-DDE	85.5	
S1SS-1	05/93	4,4'-DDE	63	C
S1SD-03	01/24/96	4,4'-DDE	52.9	J
S1SS-4SD	07/28/95	4,4'-DDE	48	

Location	Date	Parameter	Results	Qual.[1]
S1SD-02	01/22/96	4,4'-DDE	41.9	
S1SD-01	01/22/96	4,4'-DDE	41.9	J
S1SS-6SD	07/28/95	4,4'-DDT	27.5	PJ
S1SS-1	05/93	Beta-BHC	99	C
S1SS-6SD	07/28/95	Dieldrin	23.3	
S1SS-6SD	07/28/95	Endosulfan I	42.5	P
S1SS-4SD	07/28/95	Endosulfan I	22	P
S1SS-1	05/93	Endosulfan II	200	C
S1SS-6SD	07/28/95	Endosulfan II	133	P
S1SS-6SD	07/28/95	Endrin aldehyde	37	P
S1SS-1	05/93	Heptachlor	60	C
SEMIVOLATILE ORGANIC COMPOUNDS				
S1SS-5SD	07/28/95	3-methylcholanthrene	690	J
S1SS-6SD	07/28/95	Acetophenone	790	J
S1SS-1	05/93	Benzo(a)pyrene	11,000	E
S1SS-5SD	07/28/95	Benzo(a)pyrene	780	J
S1SS-6SD	07/28/95	Benzo(b)fluoranthene	1,370	J
S1SS-1	05/93	Benzo(g,h,i)perylene	7,000	E
S1SS-5SD	07/28/95	Benzo(g,h,i)perylene	760	J
S1SS-6SD	07/28/95	Benzo(g,h,i)perylene	515	J
S1SD-02	01/22/96	Bis(2-chloroisopropyl)ether	11	J
S-2	05/90	Bis(2-ethylhexyl)phthalate	2,000	J
S1SD-02	01/22/96	Chlorodibromomethane	1	J
S1SS-1	05/93	Chrysene	14,000	
S1SS-6SD	07/28/95	Chrysene	600	J
S1SS-6SD	07/28/95	Di-n-butyl phthalate	475	J
S1SS-5SD	07/28/95	Dibenzo(a,h)anthracene	610	J
S1SS-6SD	07/28/95	Fluoranthene	520	J
S1SS-4SD	07/28/95	Hexachlorophene	8,100	

TABLE 4-3

CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 1
NAS KEY WEST
PAGE 4 OF 4

Location	Date	Parameter	Results	Qual.(1)
SEMIVOLATILE ORGANIC COMPOUNDS (cont.)				
S1SS-6SD	07/28/95	Hexachlorophene	4,800	
S1SS-5SD	07/28/95	Hexachlorophene	1,200	
S1SS-1	05/93	Indeno(1,2,3-cd)pyrene	5,900	
S1SS-5SD	07/28/95	Indeno(1,2,3-cd)pyrene	710	J
S1SS-1	05/93	Phenanthrene	10,000	
S1SS-1	05/93	Pyrene	18,000	
S1SS-6SD	07/28/95	Pyrene	1,020	J
S1SS-3	05/93	Pyrene	680	
VOLATILE ORGANIC COMPOUNDS (μg/kg)				
S1SS-6SD	07/28/95	Acetone	150	
S1SS-4SD	07/28/95	Acetone	95	
S-2	05/90	Acetone	49	J
S1SS-6SD	07/28/95	Carbon disulfide	13.5	J
S1SD-03	01/24/96	Chloromethane	21	
S1SD-02	01/22/96	Dibromomethane	1	J
S1SD-02	01/22/96	Methyl methacrylate	3	J
S-2	05/90	Methylene chloride	20	J
S1SS-4SD	07/28/95	Tetrachloroethene	9	J
S1SD-02	01/22/96	Toluene	1	J
S1SS-4SD	07/28/95	Xylenes (total)	13	J

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-4).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

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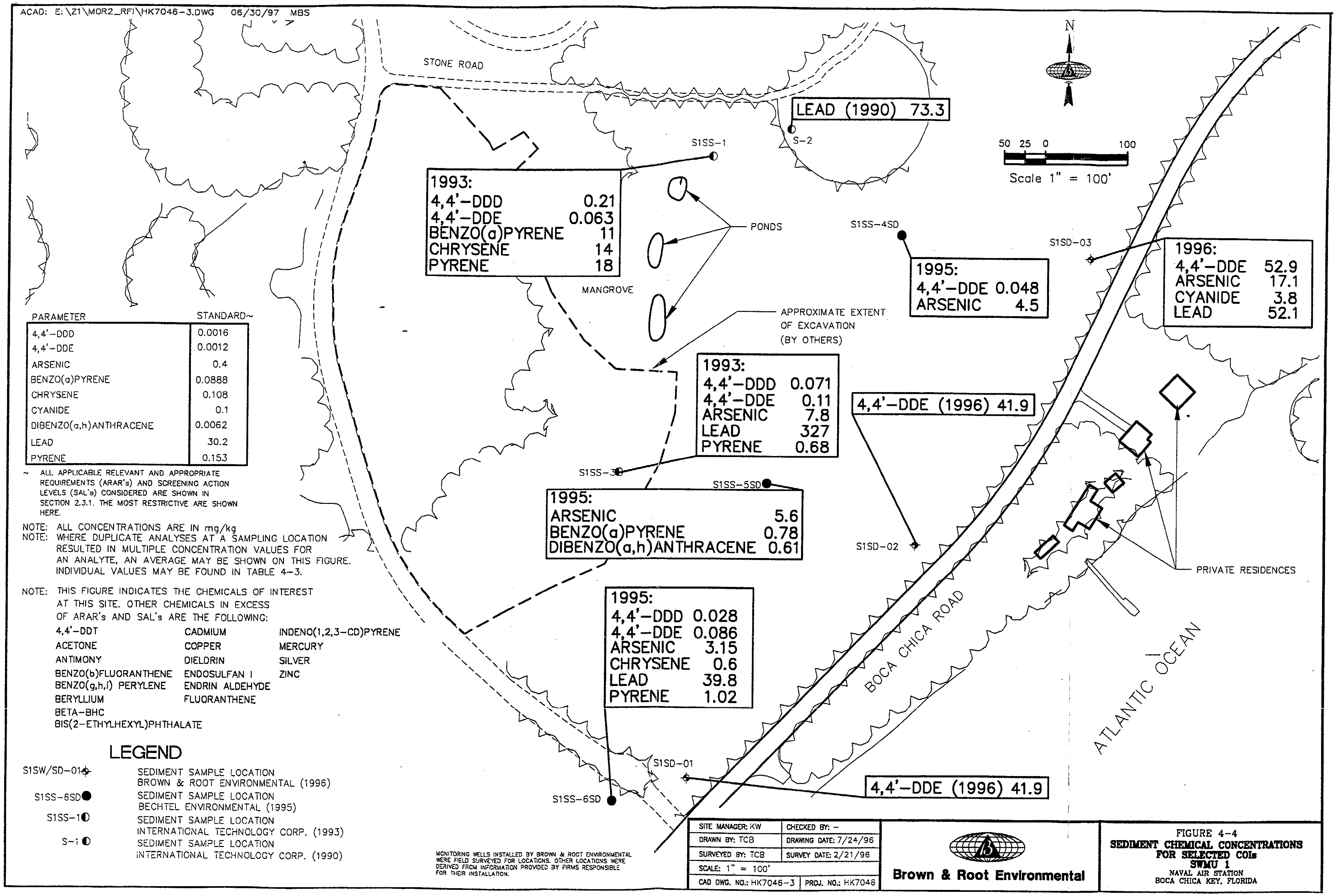


PARAMETER	STANDARD~
4,4'-DDD	0.0016
4,4'-DDE	0.0012
ARSENIC	0.4
BENZO(a)PYRENE	0.0888
CHRYSENE	0.108
CYANIDE	0.1
DIBENZO(a,h)ANTHRACENE	0.0062
LEAD	30.2
PYRENE	0.153

were detected at S1SS-5SD, with dibenzo(a,h)anthracene detected at its highest level in sediment (0.61 mg/kg). In general, SVOCs were detected only at low levels throughout the remainder of the interior region.

4.1.5.2.3 Pesticides

Several pesticides were detected in sediment taken from the Open Disposal Area. 4,4'-DDD and 4,4'-DDE were detected at S1SS-1, along with peak values of beta-benzene hexachloride(BHC) (0.099 mg/kg) and endosulfan II (0.2 mg/kg). With the exception of beta-BHC, these compounds were also found in sediment from S1SS-6SD. Maximum values of 4,4'-DDT (0.0275 mg/kg), dieldrin (0.023 mg/kg), endosulfan I (0.043 mg/kg), and endrin aldehyde (0.037 mg/kg) were also found there. S1SS-3, also on the edge of the excavated area, showed evidence of 4,4'-DDE and 4,4'-DDD contamination, while 4,4'-DDE and endosulfan I were detected at S1SS-4SD, southeast of the stone fill area. 4,4'-DDE was also detected in 1996 at S1SD-01, S1SD-02, and S1SD-03.

4.1.5.2.4 Polychlorinated Biphenyls

No PCBs were detected in sediment at SWMU 1.

4.1.5.2.5 Metals and Inorganics

Metal and inorganic contamination of sediment appears fairly widespread throughout the interior region of the Open Disposal Area, west of Boca Chica Road and south of the Stone Road. Arsenic, beryllium, cadmium, copper, lead, mercury, and zinc were detected in excess of the most conservative ARAR/SAL criteria. S1SS-3, at the eastern edge of the excavated area, contained peak values of mercury (1.9 mg/kg), silver (3.5 mg/kg), zinc (168 mg/kg), and lead (327 mg/kg). Evidence of arsenic contamination in excess of the 0.4-mg/kg proposed RCRA action level was also found there. Although S1SS-3 generally contained the highest concentrations of metals seen in sediment at the site, analysis of samples from S1SS-6SD, where both pesticides and VOCs were a potential problem, returned the broadest spectrum of metal contamination. Cadmium contamination appeared to be at its highest level in that area, with a concentration of 1.8 mg/kg. S1SD-03, sampled in 1996 near Boca Chica Road in the northeastern interior region of SWMU 1, showed arsenic and cyanide at levels of 17.1 and 3.8 mg/kg, respectively. Apart from lead, these were the only inorganics detected in excess of ARAR/SAL criteria at S1SD-03. Other sampling points near Boca Chica Road, including S1SS-4, S1SS-5, S1SD-2 and S1SD-1, contained various metal and inorganic compounds, although the levels and frequencies of detection were less than those at the other locations discussed in this section.

4.1.5.3 Surface Water

Like sediment samples, surface water was collected and analyzed from locations within the interior portion of the site, between Boca Chica Road and the Stone Road. Chemicals that were detected in surface water samples are listed in Table 4-4. This table lists analytical results from historical sampling and the Supplemental RFI/RI. The results from duplicate samples are averaged in Table 4-4. Metals and inorganics were the dominant class of contaminants in these samples, with both the maximum degree of contamination and the broadest range of contaminants found in the southwestern part of the site. This distribution is shown in Figure 4-5.

FDEP Surface Water Criteria, EPA Surface Water Criteria, National Surface Water Criteria, and EPA Region III Marine and Fresh Water Criteria were all considered as ARARs/SALs to establish the most conservative picture of contamination. The most restrictive ARAR or SAL criteria was compared to each chemical concentration discussed in this section. Table 2-5 presents the criteria considered.

4.1.5.3.1 Volatile Organic Compounds

S1SS-2, at the southwestern edge of the excavated area, and S1SS-6SW, south of the excavated area, were the only surface-water samples that contained detectable levels of VOCs. Carbon disulfide was present in S1SS-2 at 3.5 µg/L, slightly in excess of the 2-µg/L EPA Region III Marine standard. Methylene chloride and acetone were detected in the same sample, but were well below ARAR and SAL levels. Acetone was also detected at S1SS-6SW.

4.1.5.3.2 Semivolatile Organic Compounds

The 3-µg/L proposed RCRA action level for bis(2-ethylhexyl)phthalate was exceeded at S-1 (5 µg/L) in the central western portion of the site where soil excavation has since taken place. This compound was also detected at concentrations equal to the proposed RCRA action level at S-2 and S1SS-6SW. Di-n-butyl phthalate was also detected at S1SS-6SW, but was below the most restrictive ARAR/SAL criteria. S1SS-1 contained detectable amounts of pyrene and chrysene at levels well below the FDEP Surface Water Criteria. S-1 contained detectable amounts of chlorbenzilate, isodrin, and kepone.

4.1.5.3.3 Pesticides

Endrin aldehyde was the only pesticide detected in surface-water samples at SWMU 1. It was detected at a concentration of 0.1 µg/L at S-1.

TABLE 4-4

CONTAMINANTS DETECTED IN SURFACE WATER AT SWMU 1
NAS KEY WEST
PAGE 1 OF 2

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (μg/L)				
S1SS-6SW	07/28/95	Aluminum	242	B
S-2	05/91	Aluminum	158	B
S-1	05/91	Aluminum	44.5	B
S1SS-6SW	07/28/95	Arsenic	1.98	B
S-1	05/91	Barium	44.5	B
S1SS-6SW	07/28/95	Barium	9.35	B
S1SS-5SW	07/28/95	Barium	6.9	B
S1SS-4SW	07/28/95	Barium	6.8	B
S-2	05/91	Barium	2.3	B
S1SS-4SW	07/28/95	Beryllium	1.2	B
S1SS-5SW	07/28/95	Beryllium	1.2	B
S1SS-6SW	07/28/95	Beryllium	0.98	B
S-2	05/91	Cadmium	13.7	
S1SS-6SW	07/28/95	Cadmium	0.19	B
S-2	05/91	Calcium	546,000	
S1SS-4SW	07/28/95	Calcium	258,000	E
S1SS-5SW	07/28/95	Calcium	257,000	E
S1SS-6SW	07/28/95	Calcium	231,000	E
S-1	05/91	Copper	272	
S-2	05/91	Copper	10.3	B
S1SS-6SW	07/28/95	Copper	6.85	B
S1SS-6SW	07/28/95	Iron	484	
S-2	05/91	Iron	75.8	B
S1SS-5SW	07/28/95	Iron	43.4	B
S1SS-4SW	07/28/95	Iron	39.7	B
S-1	05/91	Lead	377	
S-2	05/91	Magnesium	1,600,000	
S1SS-5SW	07/28/95	Magnesium	1,220,000	E
S1SS-4SW	07/28/95	Magnesium	1,190,000	E
S1SS-6SW	07/28/95	Magnesium	920,000	E
S1SS-6SW	07/28/95	Manganese	12.1	B
S1SS-4SW	07/28/95	Manganese	1.7	B
S1SS-5SW	07/28/95	Manganese	1.3	B
S-1	05/91	Mercury	8.4	
S1SS-6SW	07/28/95	Mercury	0.08	B
S-2	05/91	Potassium	454,000	
S1SS-5SW	07/28/95	Potassium	381,000	
S1SS-4SW	07/28/95	Potassium	362,000	
S1SS-6SW	07/28/95	Potassium	297,000	
S-2	05/91	Sodium	13,100,000	
S1SS-5SW	07/28/95	Sodium	9,430,000	
S1SS-4SW	07/28/95	Sodium	9,050,000	
S1SS-6SW	07/28/95	Sodium	7,620,000	
S1SS-2	05/93	Sulfide	9,500	
S1SS-5SW	07/28/95	Thallium	4.3	B
S1SS-6SW	07/28/95	Vanadium	1.88	B
S-1	05/91	Zinc	731	
S1SS-6SW	07/28/95	Zinc	25.8	B
S1SS-5SW	07/28/95	Zinc	2.4	B
S1SS-4SW	07/28/95	Zinc	2.1	B
PESTICIDES/PCBs (μg/L)				
S-1	05/91	Endrin aldehyde	0.1	J
SEMIVOLATILE ORGANIC COMPOUNDS (μg/L)				
S-1	05/91	Bis(2-ethylhexyl)phthalate	5	BJ
S1SS-6SW	07/28/95	Bis(2-ethylhexyl)phthalate	3	J
S-2	05/91	Bis(2-ethylhexyl)phthalate	3	BJ
S-1	05/91	Chlorobenzilate	0.5	

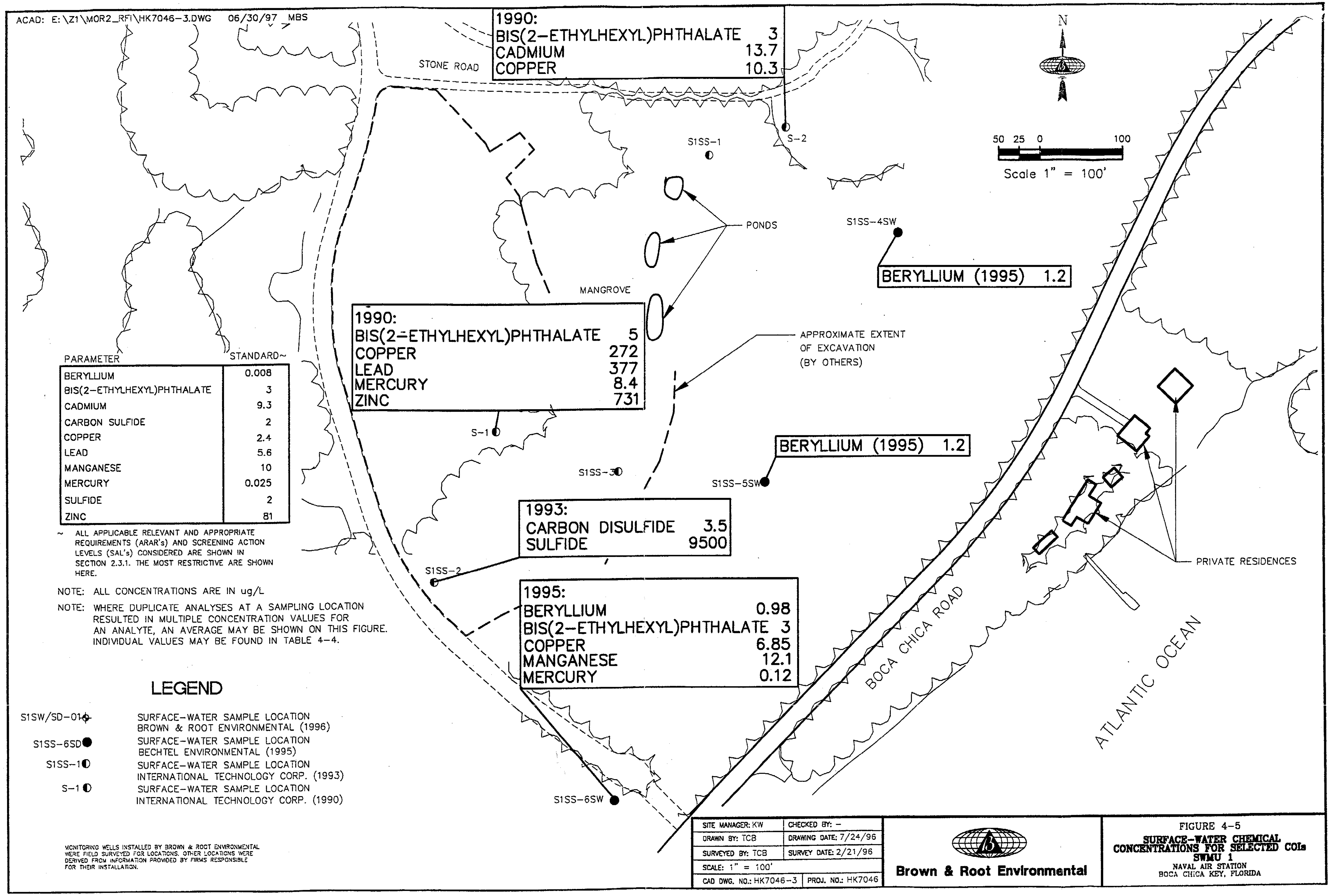
TABLE 4-4

CONTAMINANTS DETECTED IN SURFACE WATER AT SWMU 1
NAS KEY WEST
PAGE 2 OF 2

Location	Date	Parameter	Result	Qual.[1]
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S1SS-1	05/93	Chrysene	1.6	
S1SS-6SW	07/28/95	Di-n-butyl phthalate	1.5	J
S-1	05/91	Isodrin	0.05	
S-1	05/91	Kepone	0.1	
S1SS-1	05/93	Pyrene	0.95	
VOLATILE ORGANIC COMPOUNDS (µg/L)				
S1SS-6SW	07/28/95	Acetone	7	J
S1SS-2	05/93	Acetone	5.5	J
S1SS-2	05/93	Carbon disulfide	3.5	J
S1SS-2	05/93	Methylene chloride	1	BJ

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-5).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.


ACAD: E:\Z1\MOR2_RFI\HK7046-3.DWG 06/30/97 MBS
STONE ROAD
1990:
BIS(2-ETHYLHEXYL)PHTHALATE 3
CADMIUM 13.7
COPPER 10.3
S-2
S1SS-1
PONDS
S1SS-4SW
BERYLLIUM (1995) 1.2
MANGROVE
1990:
BIS(2-ETHYLHEXYL)PHTHALATE 5
COPPER 272
LEAD 377
MERCURY 8.4
ZINC 731
APPROXIMATE EXTENT
OF EXCAVATION
(BY OTHERS)
S-1
S1SS-3
BERYLLIUM (1995) 1.2
S1SS-5SW
1993:
CARBON DISULFIDE 3.5
SULFIDE 9500
S1SS-2
1995:
BERYLLIUM 0.98
BIS(2-ETHYLHEXYL)PHTHALATE 3
COPPER 6.85
MANGANESE 12.1
MERCURY 0.12
S1SS-6SW
PRIVATE RESIDENCES
BOCA CHICA ROAD
ATLANTIC OCEAN
N
50 25 0 100
Scale 1" = 100'
PARAMETER STANDARD~
BERYLLIUM 0.008
BIS(2-ETHYLHEXYL)PHTHALATE 3
CADMIUM 9.3
CARBON SULFIDE 2
COPPER 2.4
LEAD 5.6
MANGANESE 10
MERCURY 0.025
SULFIDE 2
ZINC 81
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN ug/L
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-4.
LEGEND
S1SW/SD-01 SURFACE-WATER SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S1SS-6SD SURFACE-WATER SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
S1SS-1 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
S-1 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-3
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-5
SURFACE-WATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.1.5.3.4 Polychlorinated Biphenyls

No PCBs were detected in surface water at SWMU 1.

4.1.5.3.5 Metals and Inorganics

Beryllium, cadmium, copper, lead, manganese, mercury, sulfide, vanadium, and zinc were all detected in excess of ARAR/SAL criteria in surface water at SWMU 1. Most of these occurrences were fairly isolated, with beryllium and copper having the highest frequency of detection. Both were detected at only 3 of 11 sample locations. Consistent with sediment analyses conducted at the same location and with soil analyses performed at the neighboring H25, S1SS-6SW contained a number of inorganics. ARAR/SAL criteria were not necessarily exceeded by the same analytes in the different media, but all inorganics detected in surface water were also seen in the sediment and soil samples in the southwest portion of the site. Of all the surface water samples, S1SS-6SW was the only location where manganese (12.1 µg/L) exceeded its ARAR/SAL level. S-1, in the center of the excavated area, was sampled in 1991 and was found to contain several metals -- copper (272 µg/L), lead (377 µg/L), mercury (8.4 µg/L), and zinc (731 µg/L). These results represent the highest levels found in inorganic surface-water analyses at SWMU 1. Sulfide was detected at S1SS-2 (9,500 µg/L) on the southwestern edge of the excavated area. Although surface-water contamination in the area around the Stone Road and the stone fill did not generally exceed ARAR/SAL criteria, beryllium exceeded its 0.008 µg/L proposed RCRA action level at S1SS-4SW (1.2 µg/L), while at S-2 cadmium slightly exceeded the 9.3 µg/L criteria used by EPA Region IV as a Chronic Surface Water Screening Value. Beryllium was also detected in the sample from S1SS-5SW at 1.2 µg/L.

4.1.5.4 Groundwater

Chemicals that were detected in groundwater samples are listed in Table 4-5. This table includes analytical results from historical sampling and the Supplemental RFI/RI. This historical sampling includes the 1986 Geraghty & Miller investigation, the 1990 IT Corporation RI, and the 1993 IT Corporation RFI/RI. Figures 4-6 through 4-9 show the distribution of contaminants defined by these investigations. Groundwater contamination beneath the site is predominantly attributable to metals. VOC, SVOC, and pesticide contamination have been documented, but each appears to be limited to the region directly under and at the edges of the excavation.

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 1 OF 6

Location	Date	Parameter	Results	Qual.[(1)]
HERBICIDES (µg/L)				
S1MW-4	01/30/96	Methyl parathion	0.02	J
INORGANICS (µg/L)				
MW4-3	05/90	Aluminum	75,800	
MW4-1	05/90	Aluminum	27,000	
MW4-5	05/90	Aluminum	9,470	
KWM-06	05/90	Aluminum	2,650	
MW4-2	05/90	Aluminum	1,880	B
KWM-07	05/90	Aluminum	1,740	
KWM-08	05/90	Aluminum	797	
KWM-05	05/90	Aluminum	405	
MW4-3	05/93	Antimony	251	
MW4-4	05/93	Antimony	238	
MW4-1	05/93	Antimony	231	
KWM-07	05/93	Antimony	222	
S1MW-1	05/93	Antimony	186	
KWM-06	05/93	Antimony	152	
KWM-08	05/93	Antimony	125	
S1MW-2	05/93	Antimony	119	
MW4-2	05/93	Antimony	109	
KWM-05	05/93	Antimony	98.1	
MW4-5	05/93	Antimony	74.2	
MW4-3	05/90	Antimony	45.4	B
MW4-1	05/90	Antimony	37.8	B
MW4-5	05/90	Antimony	35.8	B
KWM-06	05/90	Antimony	32.6	B
MW4-2	05/93	Arsenic	94.5	
MW4-2	05/90	Arsenic	37	
S1MW-6	01/30/96	Arsenic	33.3	
KWM-07	05/93	Arsenic	29.7	
KWM-06	05/93	Arsenic	25.8	
S1MW-2	05/93	Arsenic	25.7	
S1MW-5	01/30/96	Arsenic	18.3	
S1MW-4	01/30/96	Arsenic	17	
MW4-5	05/93	Arsenic	12.5	
KWM-08	05/93	Arsenic	10.9	
KWM-05	07/86	Arsenic	10	
KWM-08	07/86	Arsenic	10	
KWM-06	07/86	Arsenic	7	
S1MW-1	05/93	Arsenic	6.7	BJ
KWM-05	05/93	Arsenic	4.4	B
MW4-3	05/90	Barium	228	E
MW4-1	05/90	Barium	145	BE
MW4-5	05/90	Barium	116	BE
KWM-06	05/90	Barium	61.1	B
S1MW-4	01/30/96	Barium	44.1	J
KWM-05	05/90	Barium	43.2	B
KWM-06	05/93	Barium	41.2	BJ
KWM-08	05/90	Barium	40.9	B
KWM-07	05/90	Barium	39.3	B
MW4-2	05/90	Barium	37.7	BE
S1MW-1	05/93	Barium	34.2	BJ
S1MW-2	05/93	Barium	31	BJ
KWM-05	05/93	Barium	30	BJ
KWM-07	05/93	Barium	30	BJ
MW4-4	05/90	Barium	24.9	B
S1MW-6	01/30/96	Barium	24	J
KWM-08	05/93	Barium	23.9	BJ

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 2 OF 6

Location	Date	Parameter	Results	Qual.(1)
INORGANICS (µg/L) (cont.)				
S1MW-5	01/30/96	Barium	19.4	J
MW4-2	05/93	Barium	16.3	BJ
MW4-4	05/93	Barium	14.7	BJ
MW4-5	05/93	Barium	14.6	BJ
MW4-1	05/93	Barium	8.4	BJ
MW4-3	05/93	Barium	7.95	BJ
KWM-06	05/93	Beryllium	1.1	BJ
KWM-07	05/93	Beryllium	1.1	BJ
KWM-05	05/93	Beryllium	1	BJ
KWM-08	05/90	Beryllium	0.94	B
KWM-05	05/90	Cadmium	9.7	
KWM-07	05/90	Cadmium	5.6	
MW4-1	05/90	Calcium	8,880,000	
MW4-3	05/90	Calcium	7,980,000	
MW4-5	05/90	Calcium	7,820,000	
MW4-2	05/90	Calcium	3,110,000	
KWM-06	05/90	Calcium	2,590,000	
KWM-08	05/90	Calcium	2,180,000	
KWM-07	05/90	Calcium	1,860,000	
KWM-05	05/90	Calcium	825,000	
S1MW-4	01/30/96	Calcium	346,000	J
S1MW-5	01/30/96	Calcium	345,000	J
S1MW-6	01/30/96	Calcium	260,000	J
MW4-1	05/90	Chromium	106	
MW4-3	05/90	Chromium	60.5	
MW4-5	05/90	Chromium	56	
KWM-06	05/90	Chromium	25.9	
MW4-2	05/90	Chromium	20.3	
KWM-07	05/93	Chromium	19.7	
KWM-08	05/90	Chromium	16.4	
KWM-07	05/90	Chromium	12.9	
S1MW-2	05/93	Chromium	12.9	
KWM-06	05/93	Chromium	12.6	
MW4-5	05/93	Chromium	12.3	
KWM-08	05/93	Chromium	10.8	
S1MW-6	01/30/96	Chromium	1.2	
KWM-07	05/90	Copper	72.8	
MW4-1	05/90	Copper	67.2	
KWM-06	07/86	Copper	60	
KWM-07	07/86	Copper	60	
MW4-4	05/90	Copper	56.8	
KWM-05	05/90	Copper	51	
KWM-08	07/86	Copper	50	
KWM-05	07/86	Copper	40	
MW4-3	05/90	Copper	36.5	
KWM-07	05/93	Copper	33	
KWM-06	05/90	Copper	30	
MW4-5	05/90	Copper	20.8	B
S1MW-2	05/93	Copper	20.8	BJ
KWM-08	05/90	Copper	17.4	B
MW4-2	05/90	Copper	13	B
KWM-06	05/93	Copper	11.2	BJ
S1MW-4	01/30/96	Copper	1.2	
S1MW-1	05/93	Cyanide	310	
S1MW-5	01/30/96	Cyanide	2.3	
S1MW-4	01/30/96	Cyanide	1.5	
S1MW-6	01/30/96	Cyanide	1.1	

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 3 OF 6

Location	Date	Parameter	Results	Qual.[1]
INORGANICS (μg/L) (cont.)				
MW4-3	05/90	Iron	20,600	E
MW4-1	05/90	Iron	14,300	E
MW4-5	05/90	Iron	10,700	E
KWM-06	05/90	Iron	7,340	E
KWM-07	05/90	Iron	5,890	
KWM-05	05/90	Iron	3,850	
MW4-2	05/90	Iron	1,540	E
KWM-08	05/90	Iron	1118	
S1MW-4	01/30/96	Iron	320	J
KWM-07	05/90	Lead	74.4	
KWM-05	05/90	Lead	65.4	
MW4-3	05/90	Lead	60.8	
KWM-06	05/90	Lead	54.8	
MW4-1	05/90	Lead	48	
KWM-07	05/93	Lead	39.2	J
MW4-4	05/90	Lead	39	
KWM-08	05/90	Lead	38.4	
S1MW-2	05/93	Lead	37.9	BJ
MW4-2	05/90	Lead	25.7	
KWM-06	05/93	Lead	24.9	
KWM-05	05/93	Lead	13.5	
S1MW-4	01/30/96	Magnesium	1,390,000	
MW4-3	05/90	Magnesium	1,380,000	
MW4-1	05/90	Magnesium	1,330,000	
KWM-07	05/90	Magnesium	1,290,000	
S1MW-5	01/30/96	Magnesium	1,070,000	
KWM-06	05/90	Magnesium	948,000	
KWM-08	05/90	Magnesium	877,000	

Location	Date	Parameter	Results	Qual.[1]
S1MW-6	01/30/96	Magnesium	744,000	
KWM-05	05/90	Magnesium	693,000	
MW4-2	05/90	Magnesium	684,000	
MW4-5	05/90	Magnesium	211,000	
S1MW-4	01/30/96	Manganese	321	J
MW4-5	05/90	Manganese	68.5	
MW4-3	05/90	Manganese	57.5	
MW4-1	05/90	Manganese	53.6	
S1MW-6	01/30/96	Manganese	44.1	J
KWM-07	05/90	Manganese	33.7	
KWM-06	05/90	Manganese	29.3	
KWM-05	05/90	Manganese	28.3	
MW4-2	05/90	Manganese	22.7	
S1MW-5	01/30/96	Manganese	2	J
KWM-07	07/86	Mercury	66	
KWM-06	07/86	Mercury	65	
KWM-08	07/86	Mercury	54	
KWM-05	07/86	Mercury	48	
S1MW-2	05/93	Mercury	5.4	
KWM-06	05/90	Mercury	0.39	
MW4-1	05/90	Mercury	0.37	
MW4-3	05/90	Mercury	0.3	
MW4-5	05/90	Mercury	0.3	
MW4-5	05/90	Nickel	45.6	
MW4-1	05/90	Nickel	35.3	B
MW4-3	05/90	Nickel	29.6	B
S1MW-4	01/30/96	Potassium	425,000	
MW4-3	05/90	Potassium	393,000	
KWM-07	05/90	Potassium	383,000	

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 4 OF 6

Location	Date	Parameter	Results	Qual.(1)
INORGANICS (µg/L) (cont.)				
MW4-1	05/90	Potassium	377,000	
KWM-06	05/90	Potassium	295,000	
KWM-08	05/90	Potassium	240,000	
S1MW-5	01/30/96	Potassium	217,000	
KWM-05	05/90	Potassium	210,000	
MW4-2	05/90	Potassium	197,000	
S1MW-6	01/30/96	Potassium	174,000	
MW4-5	05/90	Potassium	66,900	
S1MW-4	01/30/96	Sodium	12,300,000	
MW4-1	05/90	Sodium	11,000,000	
KWM-07	05/90	Sodium	10,700,000	
S1MW-5	01/30/96	Sodium	8,780,000	
KWM-06	05/90	Sodium	8,170,000	
KWM-08	05/90	Sodium	7,230,000	
S1MW-6	01/30/96	Sodium	5,900,000	
KWM-05	05/90	Sodium	5,850,000	
MW4-2	05/90	Sodium	5,620,000	
MW4-5	05/90	Sodium	1,770,000	
MW4-3	05/90	Sodium	1,150,000	
S1MW-4	01/30/96	Thallium	20.1	J
S1MW-5	01/30/96	Thallium	10.9	J
KWM-08	05/93	Tin	107	BJ
S1MW-1	05/93	Tin	82.3	BJ
MW4-1	05/90	Vanadium	106	
MW4-3	05/90	Vanadium	64.6	
MW4-5	05/90	Vanadium	41.2	B
KWM-06	05/90	Vanadium	24.4	B
KWM-08	05/90	Vanadium	20.4	B
KWM-07	05/90	Vanadium	16.8	B
MW4-2	05/90	Vanadium	11	B
MW4-2	05/93	Zinc	221	
KWM-06	05/90	Zinc	142	
KWM-07	05/90	Zinc	83.4	
KWM-07	05/93	Zinc	79.9	J
MW4-1	05/90	Zinc	70.7	
MW4-5	05/90	Zinc	60.7	
KWM-05	05/90	Zinc	59.3	
S1MW-2	05/93	Zinc	55.4	
MW4-3	05/90	Zinc	49.8	
KWM-06	05/93	Zinc	38.2	J
MW4-2	05/90	Zinc	19.7	B
KWM-05	05/93	Zinc	18.3	B
KWM-08	05/90	Zinc	18	B
KWM-08	05/93	Zinc	13	B
S1MW-1	05/93	Zinc	7.4	B
MW4-4	05/90	Zinc	7	B
MW4-5	05/93	Zinc	6	B
MISCELLANEOUS ANALYSES (mg/L)				
KWM-07	07/86	Total dissolved solids	42,000	
KWM-08	07/86	Total dissolved solids	32,000	
KWM-06	07/86	Total dissolved solids	31,000	
KWM-05	07/86	Total dissolved solids	24,000	
PESTICIDES/PCBs (µg/L)				
S1MW-4	01/30/96	Aldrin	0.04	J
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)				
KWM-06	07/86	1,2-dichlorobenzene	1.2	
S1MW-4	01/30/96	2-methylnaphthalene	268	

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 5 OF 6

Location	Date	Parameter	Results	Qual.(1)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
MW4-2	05/90	4-chloroanline	4.25	J
S1MW-4	01/30/96	Acenaphthene	18	
KWM-05	07/86	Acenaphthene	3.4	
KWM-05	05/90	Acenaphthylene	8	J
KWM-05	07/86	Acenaphthylene	6.4	
KWM-05	05/93	Acenaphthylene	4.6	
MW4-4	05/90	Bis(2-ethylhexyl)phthalate	4	J
KWM-07	05/90	Bis(2-ethylhexyl)phthalate	3	BJ
KWM-05	05/90	Bis(2-ethylhexyl)phthalate	2	BJ
KWM-05	05/93	Chrysene	1.1	
S1MW-4	01/30/96	Dibenzofuran	8	J
KWM-06	07/86	Diethyl phthalate	1.2	
S1MW-4	01/30/96	Fluoranthene	8	J
KWM-05	05/90	Fluoranthene	3	J
S1MW-4	01/30/96	Fluorene	36	
KWM-05	07/86	Fluorene	9.1	
KWM-07	07/86	Fluorene	1	
S1MW-4	01/30/96	Naphthalene	725	
KWM-05	07/86	Naphthalene	34	
S1MW-4	01/30/96	Phenanthrene	51	
KWM-05	07/86	Phenanthrene	8.6	
KWM-07	07/86	Phenanthrene	1.6	
S1MW-4	01/30/96	Pyrene	8	J
KWM-05	05/90	Pyrene	5	J
KWM-05	05/93	Pyrene	3.1	
KWM-05	07/86	Pyrene	1.1	
VOLATILE ORGANIC COMPOUNDS (µg/L)				
MW4-3	05/93	1,1,1-trichloroethane	0.8	J
KWM-07	05/90	1,2-dichloroethene (total)	8	
MW4-5	05/90	1,2-dichloroethene (total)	7	
KWM-06	05/90	1,2-dichloroethene (total)	1	J
S1MW-4	01/30/96	4-methyl-2-pentanone	23	
MW4-2	05/90	2-butanone	2	J
S1MW-1	05/93	Acetone	11	
MW4-2	05/90	Acetone	3.5	J
MW4-4	05/90	Acetone	1	J
S1MW-4	01/30/96	Benzene	25	
KWM-05	07/86	Benzene	3.2	
KWM-06	07/86	Benzene	1.1	
S1MW-4	01/30/96	Bromomethane	5	
S1MW-4	01/30/96	Carbon disulfide	7	
S1MW-6	01/30/96	Carbon disulfide	5	J
MW4-1	05/90	Carbon disulfide	5	
MW4-5	05/90	Carbon disulfide	5	B
MW4-2	05/90	Carbon disulfide	4.5	BJ
MW4-3	05/90	Carbon disulfide	2	BJ
S1MW-1	05/93	Carbon disulfide	2	J
KWM-05	05/90	Carbon disulfide	1	J
KWM-06	05/90	Carbon Disulfide	1	J
KWM-07	07/86	Chlorobenzene	5.2	
KWM-07	05/93	Chlorobenzene	3.5	
KWM-06	07/86	Chlorobenzene	1.2	
S1MW-4	01/30/96	Chlorobenzene	1	J
S1MW-4	01/30/96	Chloromethane	2	J
KWM-07	05/93	Cis-1,2-dichloroethene	5.8	
MW4-5	05/93	Cis-1,2-dichloroethene	1.5	J
S1MW-2	05/93	Cis-1,2-dichloroethene	1.4	

TABLE 4-5

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 1
NAS KEY WEST
PAGE 6 OF 6

Location	Date	Parameter	Results	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
KWM-05	07/86	Ethylbenzene	7.9	
S1MW-4	01/30/96	Ethylbenzene	6	
S1MW-6	01/30/96	Iodomethane	3	J
S1MW-4	01/30/96	Iodomethane	3	J
S1MW-5	01/30/96	Iodomethane	2	J
KWM-05	07/86	m-xylene	15	
KWM-07	07/86	Methylene chloride	9.7	
KWM-05	07/86	Methylene chloride	5.8	
KWM-08	07/86	Methylene chloride	5.4	BG*
KWM-06	07/86	Methylene chloride	4.1	BG*
MW4-2	05/90	Methylene chloride	2	BJ
MW4-3	05/90	Methylene chloride	2	BJ
MW4-5	05/90	Methylene chloride	2	BJ
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
KWM-05	05/'90	Methylene chloride	1	BJ
KWM-06	05/90	Methylene chloride	1	BJ
KWM-08	05/90	Methylene chloride	1	BJ
MW4-1	05/90	Methylene chloride	1	BJ
S1MW-1	05/93	Methylene chloride	1	BJ
KWM-05	07/86	o+p-xylenes	20	
S1MW-4	01/30/96	Styrene	2	J
KWM-05	07/86	Toluene	11	
S1MW-4	01/30/96	Toluene	7	
S1MW-5	01/30/96	Toluene	3	J
KWM-07	07/86	Toluene	1.2	
KWM-07	07/86	Trans-1,2-dichloroethene	6	
KWM-06	07/86	Trans-1,2-dichloroethene	2.5	
KWM-06	07/86	Vinyl chloride	16	

Location	Date	Parameter	Results	Qual.(1)
KWM-06	05/90	Vinyl chloride	7	J
KWM-07	05/90	Vinyl chloride	5	J
KWM-06	05/93	Vinyl chloride	3.2	
KWM-07	05/93	Vinyl chloride	2.9	J
KWM-07	07/86	Vinyl chloride	2	BG*
S1MW-4	01/30/96	Vinyl chloride	1	J
KWM-05	05/93	Xylenes (total)	4.8	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL (see Table 2-6).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

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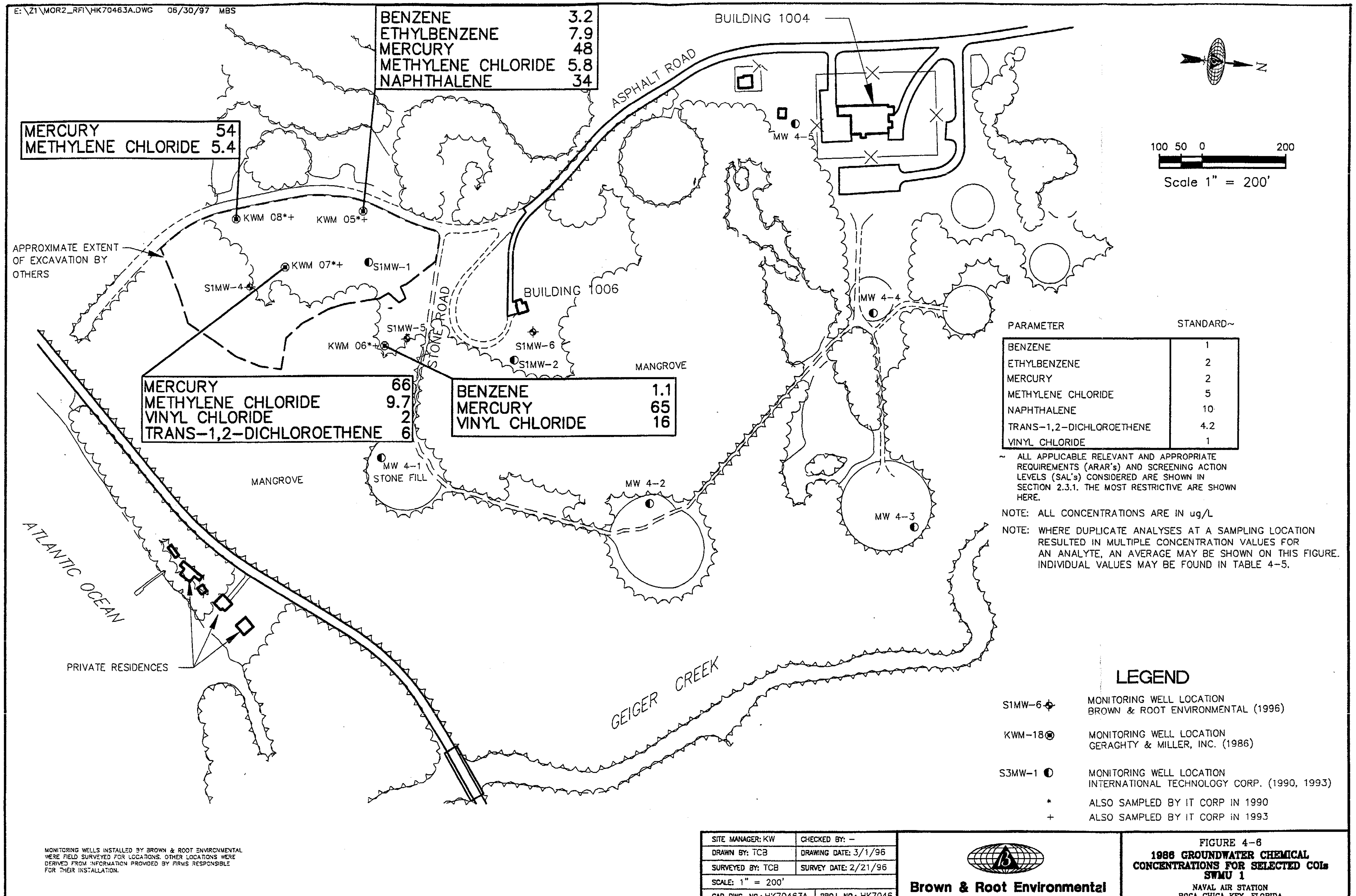
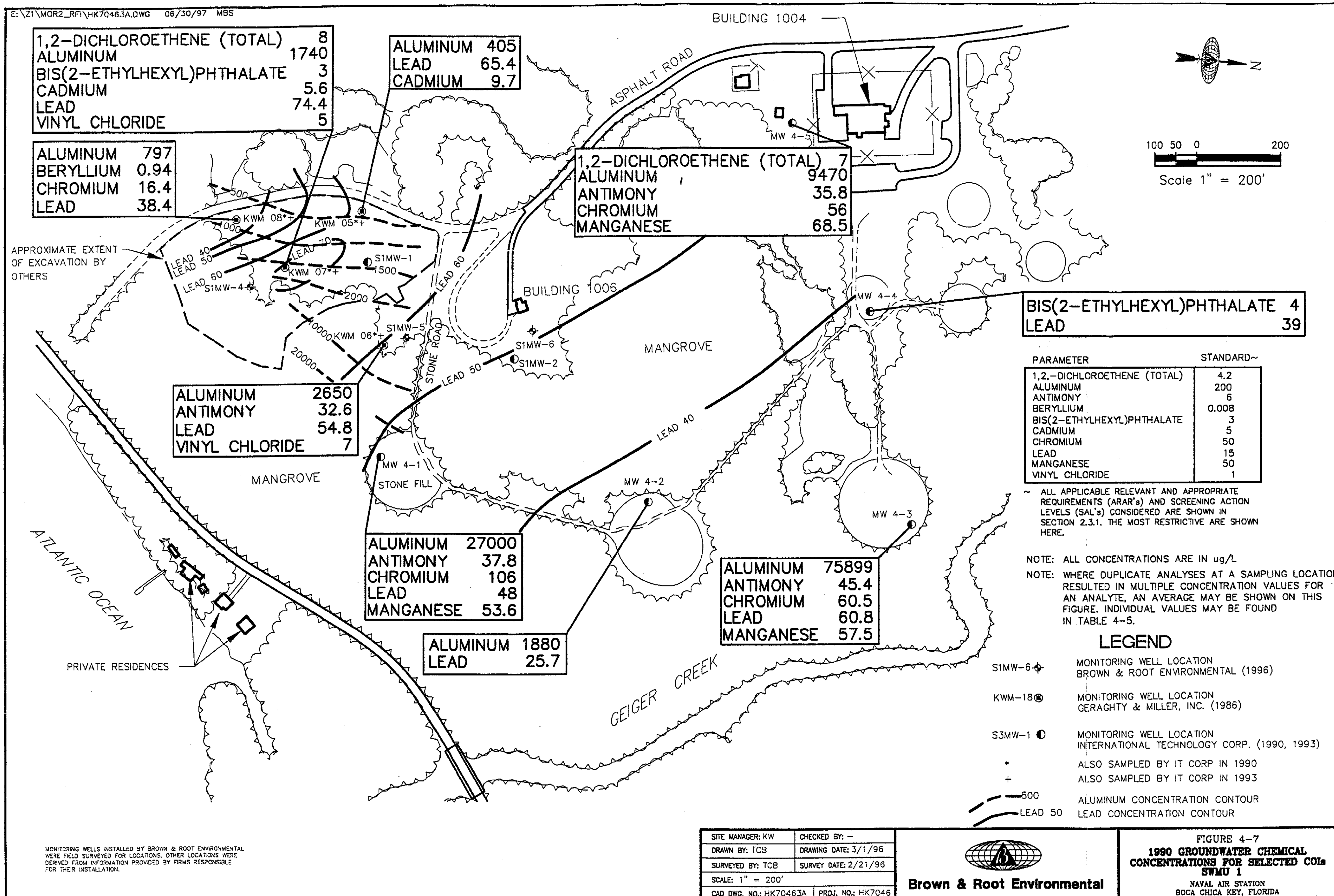

E:\Z1\MOR2_RFI\HK70463A.DWG 06/30/97 MBS
BENZENE 3.2
ETHYLBENZENE 7.9
MERCURY 48
METHYLENE CHLORIDE 5.8
NAPHTHALENE 34
MERCURY 54
METHYLENE CHLORIDE 5.4
BUILDING 1004
ASPHALT ROAD
MW 4-5
KWM 08*+
KWM 05*+
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
KWM 07*+
S1MW-1
S1MW-4
BUILDING 1006
STONE ROAD
S1MW-5
KWM 06*+
S1MW-6
S1MW-2
MANGROVE
MW 4-4
MERCURY 66
METHYLENE CHLORIDE 9.7
VINYL CHLORIDE 2
TRANS-1,2-DICHLOROETHENE 6
BENZENE 1.1
MERCURY 65
VINYL CHLORIDE 16
MW 4-1
STONE FILL
MANGROVE
MW 4-2
MW 4-3
ATLANTIC OCEAN
PRIVATE RESIDENCES
GEIGER CREEK
N
100 50 0 200
Scale 1" = 200'
PARAMETER STANDARD~
BENZENE 1
ETHYLBENZENE 2
MERCURY 2
METHYLENE CHLORIDE 5
NAPHTHALENE 10
TRANS-1,2-DICHLOROETHENE 4.2
VINYL CHLORIDE 1
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN ug/L
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-5.
LEGEND
S1MW-6 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
KWM-18 MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)
S3MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
* ALSO SAMPLED BY IT CORP IN 1990
+ ALSO SAMPLED BY IT CORP IN 1993
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: –
DRAWN BY: TCB
DRAWING DATE: 3/1/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 200'
CAD DWG. NO.: HK70463A
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-6
1986 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

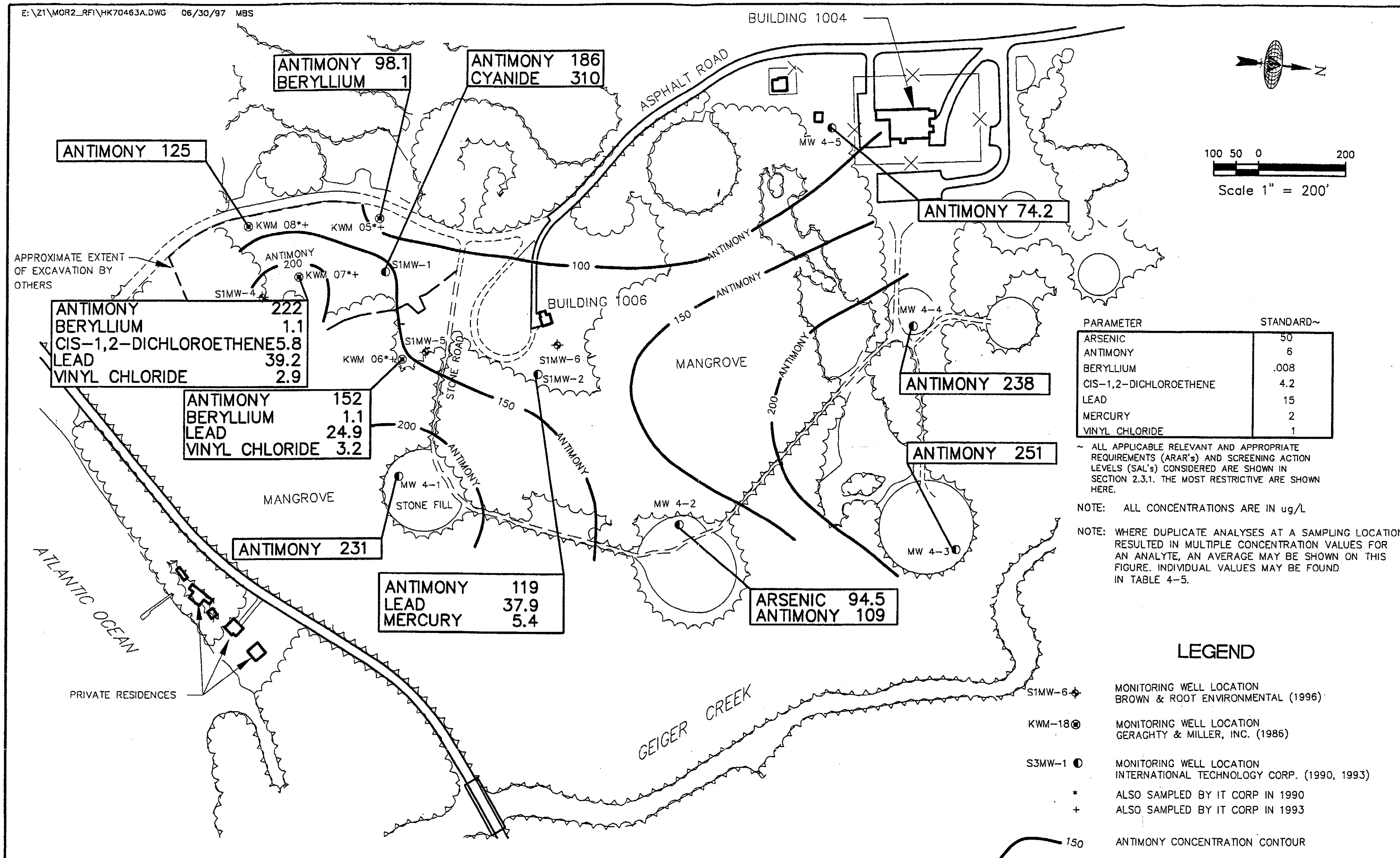


PARAMETER	STANDARD~
1,2,-DICHLOROETHENE (TOTAL)	4.2
ALUMINUM	200
ANTIMONY	6
BERYLLIUM	0.008
BIS(2-ETHYLHEXYL)PHTHALATE	3
CADMIUM	5
CHROMIUM	50
LEAD	15
MANGANESE	50
VINYL CHLORIDE	1

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-5.



PARAMETER	STANDARD~
ARSENIC	50
ANTIMONY	6
BERYLLIUM	.008
CIS-1,2-DICHLOROETHENE	4.2
LEAD	15
MERCURY	2
VINYL CHLORIDE	1

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-5.

LEGEND

S1MW-6 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

KWM-18 — MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)

S3MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)

* ALSO SAMPLED BY IT CORP IN 1990

\+ ALSO SAMPLED BY IT CORP IN 1993

150 — ANTIMONY CONCENTRATION CONTOUR

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB	DRAWING DATE: 3/1/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 200'	
CAD DWG. NO.: HK70463A	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-8
1993 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

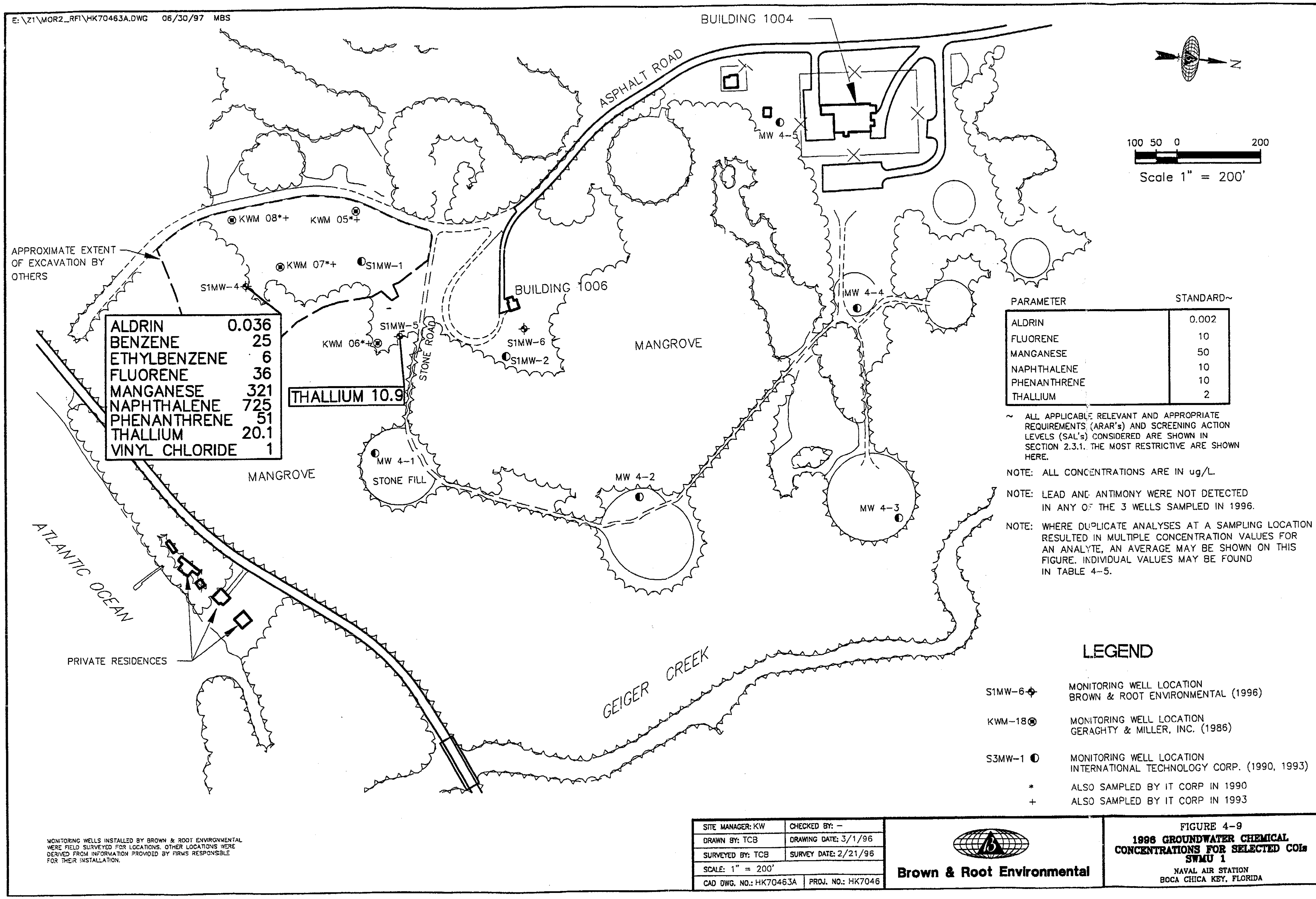


FIGURE 4-9
1996 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 1
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

Although the groundwater under the site is designated G-III (nonpotable), Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs), Florida MCLs, FDEP Guidance Concentrations, and proposed RCRA Action Levels were all considered as ARARs/SALs to be conservative. The most restrictive criteria was used in evaluating the nature and extent of groundwater contamination; those criteria are presented in Table 2-6.

4.1.5.4.1 Volatile Organic Compounds

VOCs were identified in the groundwater underlying the site in 1986, 1990, and 1993. In the 1986 study, benzene, ethylbenzene, methylene chloride, trans-1,2- DCE, and vinyl chloride were found in wells in the vicinity of the future excavation. Based on a sample from KWM-05, benzene (3.2 µg/L) and ethylbenzene (7.9 µg/L) contamination appeared to be at maximum directly below the future excavation area. Both compounds were also detected in excess of ARAR/SAL criteria in 1996, but concentrations were reduced from 1986 levels at SWMU 1. Methylene chloride and trans-1,2-DCE were detected at their highest levels beneath the future excavation in KWM-07, at 9.7 µg/L and 6 µg/L, respectively. Vinyl chloride was detected in KWM-07, but its peak detected concentration (16 µg/L) came from KWM-06, slightly to the east of the excavation. 1,2-DCE (total) and vinyl chloride were the only VOCs found to exceed their ARAR/SAL criteria in the Preliminary RI. The RFI/RI resampled the initial investigation wells and sampled additional locations as well. There were only two instances of VOC contamination above acceptable levels, as defined by ARAR and SAL criteria. Vinyl chloride was detected in samples taken from KWM-06 and 07, but in both cases the concentrations were reduced from 1986 levels. The maximum level of vinyl chloride was reduced to 3.2 µg/L in KWM-06. In 1996, vinyl chloride was only detected once at S1MW-4, and the concentration continued to drop to 1 µg/L. Cis-1,2-DCE was found in KWM-07 at 5.8 µg/L, which is just slightly above the most restrictive ARAR/SAL of 4.2 µg/L.

4.1.5.4.2 Semivolatile Organic Compounds

Before 1996, SVOCs were identified in several wells in the excavated area, but only two compounds exceeded the most conservative ARAR/SALs. Bis(2-ethylhexyl)phthalate was slightly in excess of its 3 µg/L proposed RCRA action level in two wells (KWM-07 and MW4-4) in 1990, while naphthalene was detected at 34 µg/L in S1MW-4 in 1986. In 1996, fluorene (36 µg/L), naphthalene (725 µg/L), and phenanthrene (51 µg/L) were detected above the ARAR/SAL criteria in S1MW-4. All of these chemicals had been detected previously at lower levels in either the same well or in KWM-05, which is farther to the northwest.

4.1.5.4.3 Pesticides

The only instances of pesticide contamination in the groundwater were in the 1996 sample from S1MW-4. Aldrin was detected at 0.04 µg/L, exceeding the 0.002 µg/L proposed RCRA action level. Methyl parathion was also found in that well, but the concentration was below that specified in the proposed RCRA action levels.

4.1.5.4.4 Polychlorinated Biphenyls

No PCBs were detected in groundwater at SWMU 1.

4.1.5.4.5 Metals and Inorganics

In general, metal levels in the groundwater beneath the Open Disposal Area appear to have peaked in the period from 1990 through 1993. In 1986, mercury was the only metal detected in excess of ARAR/SAL criteria at the site; the maximum value of 66 µg/L was found in a sample from KWM-07. In 1990 mercury was detected in several wells, but was below the SDWA MCL. In 1993, S1MW-2 registered a mercury concentration of 5.4 µg/L, which exceeds the 2 µg/L MCL, but is less than 1986 mercury levels at SWMU 1. Mercury was not detected in 1996. In 1990, lead was detected throughout the site, as shown by isopleths in Figure 4-7. The maximum concentration of lead occurred at KWM-07, which was within the later-excavated area. The extent and degree of lead contamination decreased in 1993, and by 1996 lead was not detected in the groundwater. Aluminum was detected in excess of ARAR/SAL criteria in all 1990 groundwater samples, with the maximum value (75,800 µg/L) occurring at MW4-3. Aluminum was not detected in 1996 supplemental RFI/RI samples. Several other metals were also detected in excess of ARAR/SAL criteria in 1990 groundwater samples. Cadmium, with a maximum of 9.7 µg/L at KWM-05, chromium, with maximum of 106 µg/L at MW4-1, and manganese, with a maximum concentration of 68.5 µg/L at MW4-5, all slightly exceeded their respective ARAR/SAL criteria. Although, all three metals were detected in several other wells in 1990, the concentrations were generally close to or below the level of concern defined by the ARAR/SALs. In 1993, none of these contaminants exceeded the criteria. Arsenic and cyanide were found in excess at their most conservative ARAR/SAL criteria in 1993. Arsenic was detected at 94.5 µg/L at MW4-2, up considerably from 1990 levels. Cyanide was detected at 310 µg/L at S1MW-1. 1996 levels of both arsenic and cyanide were considerably less than 1993 concentrations. Manganese was found in S1MW-4 at a concentration of 321 µg/L in 1996, which is well above previous levels. Antimony and beryllium were first detected in the groundwater by IT Corporation in 1990, but were more widespread in 1993. In 1990, beryllium was detected in a sample well (KWM-08) at 0.94 µg/L, while antimony exceeded the most conservative ARAR/SAL criteria in 4 wells, with the maximum concentration (45.4 µg/L) at MW4-3. In 1993, beryllium contamination occurred in several wells within and around the excavated region. The maximum 1993 concentration of 1.1 µg/L occurred in samples from both KWM-06 and -07. Antimony was detected in every 1993 groundwater sample, with concentrations that exceeded 200 µg/L in several wells in different regions of the site. Figure 4-8 shows isopleths that include antimony distribution. Antimony and beryllium were not detected during 1996 sampling. Apart from manganese, thallium was the only metal detected in the 1996 analyses in excess of the ARAR/SAL criteria. Thallium had not been detected in previous sampling and was found in two wells in 1996; S1MW-4, in the excavated area, registered the highest thallium concentration at 20.1 µg/L.

4.1.5.5 Summary of Contaminant Release

Most of the contamination found in the environment at SWMU 1 is directly attributable to the its past use as a burn area and an open disposal facility. The site received general refuse and waste associated with aircraft operations and maintenance for more than two decades. These wastes might have included hydraulic fluids, paint thinners, waste oils, and solvents. Investigations detected volatiles, semivolatiles, metals and inorganics, and pesticides at the site, although the occurrence of compounds from medium to medium was not always geographically or temporally consistent. The volatiles, semivolatiles, and metals probably are related to disposal activities at the site. VOCs that were found predominantly in groundwater directly beneath the excavated area where most disposal activities occurred probably resulted from the migration of waste organics and solvents through the now-removed soil. SVOCs and metals (major soil and sediment contaminants) might have been primary wastes disposed of at the site, or they might have been secondary components of wastes resulting from solvent or organic contact with machinery or metal containers.

VOCs and metals were the predominant groundwater contaminants. Metals were detected in the 1990 and 1993 investigations by IT Corporation, with aluminum and lead detected most frequently in 1990 and antimony in 1993. These detentions of widespread metal contamination in the groundwater in the past could not be duplicated in the January 1996 sampling event. A number of VOCs, including 1,2-DCE, benzene, ethylbenzene, vinyl chloride, and methylene chloride were detected in the 1986 groundwater survey in the immediate vicinity of the area that was later excavated. The frequency and magnitude of VOC detections in the groundwater has declined over the years.

Metals, SVOCs, and pesticides were the most significant soil and sediment contaminants at SWMU 1. Investigations detected a number of VOCs in soil or sediment including acetone, carbon disulfide, ethylbenzene, methylene chloride, toluene, xylene, chloromethane, dibromomethane, and tetrachloroethene but, with the exception of acetone and carbon disulfide in sediment, concentrations were always below the most restrictive ARAR/SAL criteria. SVOC and metal contamination did not seem to be limited to a particular region of the site, although SVOC contamination was highest in the north-central and northeast portions of SWMU 1. SVOCs found in excess of ARAR/SAL criteria in soil or sediment at the site include benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(f)fluoranthene, fluoranthene, chrysene, pyrene, benzo(a)pyrene, dibenzo-(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, tin, vanadium, and zinc were detected in soil or sediment samples, although many were below the most restrictive ARAR/SAL criteria. In soil, peak metal concentrations were found almost exclusively in the most northwesterly sample. The maximum sediment concentrations were spread among several samples, but S1SS-3, a sample taken in 1993 from the edge of the excavated area seemed to contain the most metals. The pesticides 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE occurred in both soil and sediment samples, with the highest levels found in soil from the northern part of the site. The presence of its biotransformation products indicates that 4,4'-DDT has been in the soil and sediment at the site for some time. Aroclor-1260 was detected at two of the soil sampling sites, both in the north-central region of SWMU 1.

Surface-water contamination at SWMU 1 consisted almost exclusively of metals. Investigations detected several SVOCs and VOCs including chrysene, di-n-butyl phthalate, methylene chloride, and pyrene, which did not exceed ARAR/SAL levels. Bis(2-ethylhexyl)phthalate, an SVOC, carbon disulfide, a VOC, and sulfide, an inorganic compound, were the only nonmetals that exceeded ARARs or SALs in surface water. All of these occurrences were isolated. The metals found in surface water were also components of soil or sediment contamination, although the occurrences were not necessarily well correlated geographically (i.e., high surface-water concentrations of a metal did not necessarily correspond to high sediment concentrations at the same location). Beryllium, cadmium, copper, lead, manganese, mercury, vanadium, and zinc all exceeded ARAR/SAL surface-water limits, but their occurrence was isolated. Metals were detected in most of the surface water samples, but S-1, which was taken in the confines of the area later excavated and S1SS-6SW to the south of the excavated area appeared to contain the greatest number of metal contaminants.

4.1.6 <u>Contaminant Fate and Transport</u>

The behavior of contaminants in the environment at SWMU 1 is described in this section. Various chemicals detected and their transport potential in the environment are discussed in Section 4.1.6.1. Persistence of detected chemicals in the environment is discussed in Section 4.1.6.2. Section 4.1.6.3 discusses contaminant trends. Chemical and physical properties of COPCs detected at SWMU 1 are presented in Appendix G.

4.1.6.1 Detected Chemicals and Transport Potential

Analytical results for the media sampled at SWMU 1 indicate halogenated and aromatic volatiles, PAHs, and pesticides are present in groundwater. PAHs, pesticides, Aroclor-1260, phthalates, ketones, and aromatic and halogenated volatiles were detected in surface soils. Pesticides, acetone, aromatic and halogenated volatiles, PAHs, and phthalates were detected in sediment samples. Acetone, pyrene, carbon disulfide, and phthalate esters were detected in surface water samples. Inorganics were detected in sediment, groundwater, surface soil, and surface water samples above background levels.

The groundwater contaminants 1,2-DCE and vinyl chloride are decomposition products of tetrachloroethene (PCE) and trichloroethene (TCE) (Cline and Vista, 1983) and might be a result of decomposition of the trichloroethene in groundwater at SWMU 1. Although the solubility and volatility of the detected VOCs make them characteristically mobile in the environment, additional migration of VOCs from soil to groundwater is not likely to be significant because of the lack of VOCs that were detected in soil and groundwater after the recent soil removal action.

Pesticides and semivolatiles, which were detected in site-related sediments and soils, are not expected to migrate significantly due to soil/water partition coefficients that strongly favor soil sorption (see Table G.3-1 in Appendix G). PAHs were detected at moderate levels in soil and low levels in groundwater during more than one sampling investigation. Since PAHs typically exhibit lower solubilities than VOCs, PAHs may be present in groundwater in association with other suspended organic matter or solids. Aldrin and methyl parathion were detected in groundwater at trace levels but were not found in other sampled media. These substances are also not normally considered highly mobile in groundwater.

PCBs, which were detected in two soil samples, are strongly sorbed to soil and are considered to exhibit low mobility and very little potential for groundwater migration.

The transport of lead in the aquatic environment is influenced by the speciation of the ion. Sorption processes appear to exert a dominant effect on the distribution of lead in the environment. Adsorption to inorganic solids, organic materials, and hydrous iron and manganese oxides usually controls the mobility of lead and results in a strong partitioning of lead to the bed sediments in aquatic systems. The sorption mechanism most important in a particular system varies with geological setting, pH, Eh, availability of ligands, dissolved and particulate concentrations, and chemical composition. Lead is strongly complexed to organic materials present in aquatic systems and soil (Clement Associates, 1985).

Metals, which were detected in site-related soils and sediments, are absorbed onto soil and sediment easily but may also exist in dissolved or suspended forms. Many metals are water-insoluble; however, some soluble species of metals have increased mobility. Arsenic, mercury, and chromium, for example, exhibit mobilities that are strongly influenced by pH and speciation or, in the case of mercury, by the presence of organic forms such as alkylated mercury compounds.

4.1.6.2 Persistence

Environmental persistence varies considerably for the classes of detected chemicals. The transformation of a chemical to degradation byproducts can be the result of many processes including biotransformation and uptake, photolysis, acid- or base-catalyzed reaction, or hydrolysis. The product chemicals may or may not be significantly different from a toxicological or physical transport perspective. If the transformational process is known or suspected, product chemicals can be predicted and the extent of transformation can be determined from chemical reaction rate data. Other transformational processes may be identified empirically from analytical data.

Although most chemicals are resistant to chemical change because of their stability or lack of reaction sites, many of the more mobile species are subject to at least limited transformation. Because of more frequent contact with reactive dissolved species and catalysts in comparison to unsaturated conditions, the contaminants found in saturated media (groundwater and saturated zone soils) are most likely to be transformed in the environment. Higher molecular-weight contaminants tend to be less mobile (due to differences in soil/water partition coefficients and solubility) and therefore less prone to chemical transformation.

PAHs exhibit very limited biodegradation rates in soil, with the heavier PAH compounds considered more persistent. PAHs can be biodegraded but the rate of degradation is slower for compounds with higher molecular weights (Clement Associates, 1985).

PCBs are considered highly persistent and undergo biodegradation at slow rates that vary according to the chlorinated isomer substitution pattern for each type of PCB congener in Aroclor mixtures.

1,2-DCE and vinyl chloride, which are byproducts of the degradation of TCE and PCE, can further degrade to lesser-chlorinated species. In addition, the low persistence of these VOCs in soil is influenced by their solubility and high volatility.

Inorganic compounds have a strong tendency to adsorb onto soil and sediment particles, a factor that greatly reduces their mobility.

4.1.6.3 Observed Chemical Contaminant Trends

PAHs (associated with residues from past activities such as open burning and waste oil disposal) were detected in several media sampled at SWMU 1 including soil, sediment, and groundwater. As described in Section 4.1.5, soils and sediments displaying elevated PAH concentrations were distributed across the site, including several locations outside of the areas excavated during a recent removal action. PAHs were also found in groundwater and surface water during more than one sampling event, and only at locations where soil or sediment PAH levels were relatively high. This concurs with the expectation that the bulk of PAH contamination tends to remain bound to soil or sediment near the source location without any tendency to dissipate significantly through surface water or groundwater transport mechanisms.

The detection of trace levels of chlorinated ethenes and benzene, toluene, ethyl benzene, and xylenes in groundwater is consistent with site history and is apparently related to past disposal of waste oil, paint thinner, and solvents. Vinyl chloride and dichloroethenes were detected at low ppb levels in wells near the center of the site during several sampling rounds. Detections of aromatic VOCs were generally significant only in earlier sampling. Because of the interim removal action completed at SWMU 1 and the fact that no VOCs were detected in 1996 sampling, it is likely that future contaminant trends will continue to display reduced or eliminated VOC concentrations.

Although lead was detected in all media at significant levels during previous sampling events, the removal action has largely mitigated lead soil contamination except for isolated hot spots. No detections of lead occurred in 1996 groundwater samples; therefore, only a limited potential exists at this time for lead migration. Some degree of migration of lead in surface soil could occur through windblown particulates or through runoff and erosional dispersion; however, the greatest concern is from lead that remains bound to surface soil that could be accidentally ingested via direct contact with soil. Elevated levels of lead that were found in a surface water sample collected before the removal action may not be representative of current conditions because post-removal sampling did not reveal elevated sediment lead concentrations in the same vicinity.

Although several other metals were detected at levels somewhat greater than background in each media, the occurrence and frequency of low-level metals contamination was different in each sampling round and in each of the media. Therefore, no obvious pattern of contamination is suggested for most metals. Antimony was detected at elevated levels (low hundreds of ppb) in all site-related and background groundwater samples collected during one early sampling round but was not detected at relatively low detection limits in other, including more recent, rounds of sampling. Since antimony is not normally found in seawater at elevated levels, this suggests that the earlier antimony data might not be trustworthy, conceivably because of analysis interferences or sensitivity problems associated with one sampling round.

Mercury was detected in several monitoring wells at levels in the mid-tens of ppb during a single sampling round; however, no recurrent pattern of mercury groundwater contamination was observed in later sampling rounds. Out of three later rounds of monitoring well sampling, mercury was only found in one sample in the 5 µg/L range and on four other occasions it was observed at trace levels, close to the reporting limit of 0.2 µg/L. In addition, mercury was infrequently detected in soil or sediment. Out of several rounds of soil sampling, only one sample (S1SS-7) revealed a notably elevated level of mercury (6.2 mg/kg), with other detections occurring sporadically and at concentrations near the 0.1 mg/kg reporting limit. Similarly, only one sediment sample revealed a level of mercury near the 2 mg/kg range. Therefore, widespread mercury contamination at SWMU 1 is not apparent, given the irreproducible nature of groundwater results and the infrequent detection of mercury in other media.

4,4'-DDT degradation products were detected at elevated levels (in the hundreds of ppb or higher) in several soil and sediment samples at SWMU 1, suggesting that 4,4'-DDT disposal or application areas are not limited to the central portion of the site. 4,4'-DDT levels are considerably lower (in the tens of ppb) along the section of the site adjacent to the Atlantic Ocean, and 4,4'-DDT degradation products were not detected in groundwater or surface water samples. It is possible that limited contaminant migration via erosional processes may have occurred for 4,4'-DDT and related compounds at SWMU 1.

Aside from 4,4'-DDT, other pesticide compounds were detected only sporadically at SWMU 1. In addition, other pesticide levels in soil were generally in the low ppb range and the specific compounds were different from those found in sediments.

Hexachlorophene was detected in soil and sediment samples from only one sampling round. Given the presence of this substance at similar levels in background, these data do not suggest a consistent pattern of contamination related to SWMU 1 activities.

Three organic compounds were detected that are considered common or ubiquitous laboratory contaminants. Despite the use of proper sampling protocols and data validation to minimize analytical bias, methylene chloride, acetone, and bis(2-ethylhexyl)phthalate remained after data validation in both site and background data sets. These compounds were detected sporadically, without demonstrating any consistent pattern of contamination associated with the SWMU 1 disposal areas.

Chlorodibromomethane, trans-1,4-dichlorobutene, bis(2-chloroisopropyl)ether, acetonitrile, acetophenone, and dibromomethane were not found in background samples and were each detected in only one sample from a given sampling medium. For these substances, which are rarely encountered at hazardous waste disposal sites, the relative significance of a single detection at levels below quantitation limits is unclear, since they were not detected elsewhere in site-related samples and are not related to known previous site activities. Based upon limited detections, it does not appear that there is a potential for widespread contamination for these compounds at SWMU 1.

4.1.7 Baseline Human Health Risk Assessment - SWMU 1

This section presents the baseline human health risk assessment for SWMU 1. It discusses the preliminary risk evaluation, data evaluation, toxicity assessment, exposure assessment, risk characterization, and remedial option goals. Conclusions about the baseline human health risk assessment are presented in Section 4.1.7.8. The baseline HHRA described in this section is a qualitative and quantitative assessment of actual or potential risks for SWMU 1. The methodologies and techniques used in the assessment are outlined in Section 3.2 of Appendix G.

4.1.7.1 Preliminary Risk Evaluation

Tables 4-6 and 4-7 summarize the preliminary risk evaluation for SWMU 1 for carcinogenic risks and noncarcinogenic risks, respectively. The risk ratio calculated assuming an industrial land use scenario is less than 1E-04 and 1.0 for carcinogenic and noncarcinogenic effects, respectively. However, the risk ratio calculated assuming a residential land use scenario is greater than 1E-04 and 1.0 for carcinogenic and noncarcinogenic effects, respectively. Thus, a baseline human health risk assessment is necessary for SWMU 1. The preliminary contributors to carcinogenic risks are benzo(a)pyrene, arsenic, and Aroclor-1260 in soils; arsenic and benzo(a)pyrene in sediment; and arsenic and beryllium surface water. The preliminary contributors to noncarcinogenic hazard quotients (HQs) are iron and manganese in soils and thallium in sediment and surface water. Appendix G, Section 3.2.1 contains the methods used for preliminary risk assessment analysis. Lead will be evaluated separately using EPA's IEUBK Lead Model (v.0.99).

4.1.7.2 Data Evaluation

A list of COPCs was developed for each environmental medium, as necessary. Only those chemicals found to be of potential concern were considered for evaluation in the quantitative risk assessment. A

TABLE 4-6

PRELIMINARY RISK EVALUATION - CARCINOGENIC EFFECTS
SWMU 1
NAS KEY WEST

Chemical*	Media Concentration (Maximum Detected Value) Soil	Media Concentration Sediment	Media Concentration Surface Water	Screening Values Residential Soil	Screening Values Residential Sediment	Screening Values Residential Surface Water	Screening Values Industrial Soil	Risk Ratio Residential Soil	Risk Ratio Residential Sediment	Risk Ratio Residential Surface Water	Risk Ratio Industrial Soil
INORGANICS											
Arsenic	6.4	17.1	1.975	0.43	0.43	0.045	3.8	1E-05	4E-05	4E-05	2E-06
Beryllium	0.2	0.28	1.2	0.15	0.15	0.016	1.3	1E-06	2E-06	8E-05	2E-07
PESTICIDES/PCBs											
4,4'-DDD	1,400	210	ND	2.7	2.7	0.28	24	5E-07	8E-08	NA	6E-08
4,4'-DDE	1,730	110	ND	1.9	1.9	0.2	17	9E-07	6E-08	NA	1E-07
4,4'-DDT	4,700	27.5	ND	1.9	1.9	0.2	17	2E-06	1E-08	NA	3E-07
Aroclor-1260	900	ND	ND	0.083	0.083	0.0087	0.74	1E-05	NA	NA	1E-06
Beta-BHC	ND	99	ND	0.35	0.35	0.037	3.2	NA	3E-07	NA	NA
Dieldrin	ND	23.25	ND	0.04	0.04	0.0042	0.36	NA	6E-07	NA	NA
Heptachlor	ND	60	ND	0.14	0.14	0.0023	1.3	NA	4E-07	NA	NA
SEMIVOLATILE ORGANIC COMPOUNDS											
Benz(a)anthracene	3,420	ND	ND	0.88	0.88	0.092	7.8	4E-06	NA	NA	4E-07
Benzo(a)pyrene	2,185	11,000	ND	0.088	0.088	0.0092	0.78	3E-05	1E-04	NA	3E-06
Benzo(b)fluoranthene	6,830	1,365	ND	0.88	0.88	0.092	7.8	9E-06	2E-06	NA	9E-07
Benzo(k)fluoranthene	410	ND	ND	8.8	8.8	0.92	78	5E-08	NA	NA	5E-09
Bis(2-ethylhexyl)phthalate	2,200	ND	0.5	46	46	4.8	410	5E-08	NA	1E-07	5E-09
Chrysene	5,435	14,000	1.6	88	88	9.2	780	6E-08	2E-07	2E-07	7E-09
Dibenzo(a,h)anthracene	604.5	610	ND	0.088	0.088	0.0092	0.78	7E-06	7E-06	NA	8E-07
Indeno(1,2,3-cd)pyrene	1,585	5,900	ND	0.88	0.88	0.092	7.8	2E-06	7E-06	NA	2E-07
VOLATILE ORGANIC COMPOUNDS											
1,1,2,2-tetrachloroethane	1	ND	ND	3.2	3.2	0.052	29	3E-10	NA	NA	3E-11
Bis(2-chloroisopropyl)ether	6	11	ND	9.1	9.1	0.26	82	7E-10	1E-09	NA	7E-11
Chloromethane	ND	21	ND	49	49	1.4	440	NA	4E-10	NA	NA
Dibromochloromethane	0.44	1	ND	7.6	7.6	0.13	68	6E-11	1E-10	NA	7E-12
Dibromomethane	ND	1	ND	0.0075	0.0075	0.00075	0.067	NA	1E-07	NA	NA
Methylene chloride	70	ND	1	85	85	4.1	760	8E-10	NA	2E-07	9E-11
Tetrachloroethene	ND	9	ND	12	12	1.1	110	NA	8E-10	NA	NA
							Risk Sums by Medium	**8E-05**	**2E-04**	**1E-04**	**9E-06**
							Risk Sums by Use Scenario		**4E-04**		**9E-06**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and pesticide/PCBs concentrations are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
NA = Not applicable.

TABLE 4-7

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 1
NAS KEY WEST
PAGE 1 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
HERBICIDES											
Methyl Parathion	ND	35.5	ND	20	20	9.1	510	NA	2E-03	NA	NA
INORGANICS											
Aluminum	7,810	2,580	242	78,000	78,000	37,000	1,000,000	1E-01	3E-02	7E-03	8E-03
Antimony	22	3	ND	31	31	15	820	7E-01	1E-01	NA	3E-02
Arsenic	6.4	17.1	1.975	23	23	11	610	3E-01	7E-01	2E-01	1E-02
Barium	100	10.3	44.5	5,500	5,500	2,600	140,000	2E-02	2E-03	2E-02	7E-04
Beryllium	0.2	0.28	1.2	390	390	180	1,000	5E-04	7E-04	7E-03	2E-04
Cadmium	11	1.8	13.7	39	39	18	1,000	3E-01	5E-02	8E-01	1E-02
Chromium VI	184	23.8	ND	390	390	180	10,000	5E-01	6E-02	NA	2E-02
Cobalt	5	ND	ND	4,700	4,700	2,200	120,000	1E-03	NA	NA	4E-05
Copper	407	430	272	3,100	3,100	1,500	82,000	1E-01	1E-01	2E-01	5E-03
Cyanide	ND	3.8	ND	1,600	1,600	730	41,000	NA	2E-03	NA	NA
Iron	28,500	2,395	484	23,000	23,000	11,000	610,000	1E+00	1E-01	4E-02	5E-02
Manganese	467	6.5	12.1	390	390	180	10,000	1E+00	2E-02	7E-02	5E-02
Mercury	6	1.9	8.4	23	23	11	610	3E-01	8E-02	8E-01	1E-02
Nickel	50	14.3	ND	1,600	1,600	730	41,000	3E-02	9E-03	NA	1E-03
Selenium	1	3.4	ND	390	390	180	10,000	3E-03	9E-03	NA	1E-04
Silver	8	3.5	ND	390	390	180	10,000	2E-02	9E-03	NA	8E-04
Thallium	ND	72.4	4.3	6.3	6.3	2.9	160	NA	1E+01	1E+00	NA
Vanadium	11.1	33.4	1.875	550	550	2,600	14,000	2E-02	6E-02	7E-04	8E-04
Zinc	869.5	168	731	23,000	23,000	11,000	610,000	4E-02	7E-03	7E-02	1E-03
PESTICIDES/PCBs											
4,4'-DDT	4,700	27.5	ND	39	39	18	1,000	1E-01	7E-04	NA	5E-03
Dieldrin	ND	23.25	ND	3.9	3.9	1.8	100	NA	6E-03	NA	NA
Endosulfan I	ND	42.5	ND	470	470	220	12,000	NA	9E-05	NA	NA
Endosulfan II	ND	200	ND	470	470	220	12,000	NA	4E-04	NA	NA
Endrin	19.7	ND	ND	23	23	11	610	9E-04	NA	NA	NA
Heptachlor	ND	60	ND	39	39	18	1,000	NA	2E-03	NA	NA
SEMIVOLATILE ORGANIC COMPOUNDS											
Acetophenone	120	790	ND	7,800	7,800	0.042	200,000	2E-05	1E-04	NA	6.E-07
Anthracene	280	ND	ND	23,000	23,000	11,000	610,000	1E-05	NA	NA	5E-07
Bis(2-chloroisopropyl)ether	6	11	ND	3,100	3,100	1,500	82,000	2E-06	4E-06	NA	7E-08

TABLE 4-7

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 1
NAS KEY WEST
PAGE 2 OF 2

	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
Chemical*	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
SEMIVOLATILE ORGANIC COMPOUNDS (cont.)											
Bis(2-ethylhexyl)phthalate	2,200	2000	5	1,600	1,600	730	41,000	1E-03	NA	7E-03	5E-05
Di-n-butyl phthalate	230	475	1.5	7,800	7,800	3,700	200,000	3E-05	6E-05	4E-04	1E-06
Fluoranthene	7,100	520	ND	3,100	3,100	1,500	82,000	2E-03	2E-04	NA	9E-05
Hexachlorophene	890	8,100	ND	23	23	11	610	4E-02	4E-01	NA	1E-03
Pyrene	6290	18,000	0.95	2,300	2,300	1,100	61,000	3E-03	8E-03	9E-04	1E-04
VOLATILE ORGANIC COMPOUNDS											
2-butanone	32	ND	ND	47,000	47,000	1,900	1,000,000	7E-07	NA	NA	3E-08
Acetone	230	150	7	7,800	7,800	3,700	200,000	3E-05	2E-05	2E-03	1E-06
Acetonitrile	9	ND	ND	470	470	220	12,000	2E-05	NA	NA	8E-07
Carbon disulfide	ND	13.5	3.5	7,800	7,800	1,000	200,000	NA	2E-06	4E-03	NA
Dibromochloromethane	0.44	1	ND	1,600	1,600	730	41,000	3E-07	6E-07	NA	1E-08
Ethylbenzene	2	ND	ND	7,800	7,800	1,300	200,000	3E-07	NA	NA	1E-08
Methyl methacrylate	ND	3	ND	6,300	6,300	2,900	160,000	NA	5E-07	NA	NA
Methylene chloride	70	ND	1	4,700	4,700	260	120,000	2E-05	NA	4E-03	6E-07
Tetrachloroethene	ND	9	ND	780	780	370	20,000	NA	1E-05	NA	NA
Toluene	7	1	ND	16,000	16,000	750	410,000	4E-07	6E-08	NA	2E-08
Xylenes (total)	7	13	ND	160,000	160,000	12,000	1,000,000	4E-08	8E-08	NA	7E-09
Hazard Sums by Medium								**5E+00**	**1E+01**	**3E+00**	**2E-01**
Hazard Sums by Use Scenario								**2E+01**			**2E-01**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCB concentrations are in μg/kg, and all water site data are in μg/L.
ND = Not detected.
NA = Not applicable.

discussion of those chemicals identified as COPCs for each medium is provided in this section. See Appendix G, Section 3.2.2 for a discussion of data evaluation approaches.

4.1.7.2.1 Soils

Several VOCs, SVOCs, pesticides, a PCB, and metals were detected in one or more of the surface soil samples collected at SWMU 1. Lead was the only chemical detected in subsurface soil samples collected at SWMU 1. The occurrence and distribution of chemicals in surface and subsurface soils are listed in Tables 4-8 through 4-10. Summary statistics, COPC selection results, and representative concentrations for chemicals detected in SWMU 1 environmental media are also presented in these tables.

The following chemicals were selected as COPCs for SWMU 1 for surface and subsurface soils:

SURFACE SOILS		SUBSURFACE SOILS	
Inorganics	Organics	Inorganics	Organics
Aluminum	2-Hexanone**	Lead**	None
Antimony	4,4'-DDD		
Arsenic	4,4'-DDE		
Beryllium	4,4'-DDT		
Cadmium	Anthracene		
Copper	Aroclor-1260		
Iron	Benz(a)anthracene		
Lead*	Benzo(a)pyrene		
Manganese	Benzo(b)fluoranthene		
Mercury	Benzo(g,h,i)perylene**		
	Benzo(k)fluoranthene		
	Chrysene		
	Dibenz(a,h)anthracene		
	Endrin aldehyde**		
	Fluoranthene		
	Phenanthrene**		
	Trans-1,4-dichloro-2-butene**		
	Indeno(1,2,3-cd)pyrene		

Lead (*) will be evaluated using the Integrated Exposure and Uptake Biokinetic (IEUBK) Lead Model (v. 0.99) for surface soils only. No quantitative toxicity values for these chemicals (**) are available; therefore, they will be evaluated qualitatively in the uncertainty section.

TABLE 4-8

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE SOIL SWMU 1 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	11/11	120-4,250	2,130	7/7	1,540-7,810	4,032	7,800	7,140	Y	C
Antimony	2/12	0.26-0.48	0.428	4/8	1.30-21.7	4.5	3.1	14.7	Y	C
Arsenic	6/12	0.63-2.7	1.4	5/8	1.2-6.4	3.09	0.43	5.83	Y	C
Barium	12/12	4.4-17.7	11	8/8	9.7-99.6	30.65	550	66.7	N	A
Beryllium	2/12	0.13-0.15	0.05	3/8	0.125-0.20	0.09	0.15	0.183	Y	C
Cadmium	4/12	0.11-0.45	0.17	8/8	.96-11.2	3.17	3.9	11.2	Y	C
Calcium	11/11	265,000-449,000	362,000	7/7	255,000-361,500	322,071	–	352,000	N	D
Chromium	12/12	1.9-15.5	6.22	8/8	7.50-184	32.91	39	108	Y	C
Cobalt	7/12	0.22-0.51	0.34	6/8	0.45-4.6	1.51	470	3.86	N	A
Copper	11/12	1.3-15.6	5.28	8/8	4.30-407	95.66	310	407	Y	C
Iron	11/11	98.1-2,260	1,290	7/7	1,900-28,500	8,243	2,300	28,500	Y	C
Lead	11/12	0.65-48.3	16.8	54/58	0.47-740	111.23	–	740	Y	H
Magnesium	11/11	1,340-24,600	7,800	7/7	3,680-16,000	9,050	–	16,000	N	D
Manganese	11/11	2.6-33.7	19.4	7/7	19.10-467	107.13	180	467	Y	C
Mercury	2/12	0.048-0.08	0.03	6/8	0.12-6.2	0.89	2.3	6.2	Y	C
Nickel	8/12	0.63-4.1	1.63	7/8	3.30-50.2	11.48	160	50.20	N	A
Potassium	11/11	48.6-944	356	7/7	248-785	479.43	–	767	N	D
Selenium	4/12	0.46-1.8	0.72	3/8	0.2425-0.61	0.57	39	0.61	N	A
Silver	0/5	Not detected	–	6/8	0.58-7.6	2.67	39	7.6	N	A
Sodium	11/11	834-18,700	4,620	7/7	888.5-5,770	3,364.07	–	5,770	N	D
Tin	2/5	0.78-2.1	1.94	4/4	3.60-11.8	7.76	4,700	11.8	N	A
Vanadium	12/12	0.8-8.8	3.71	8/8	3.35-11.1	6.74	55	9.48	N	A
Zinc	12/12	0.63-89.1	19	8/8	15.80-869.5	300.26	2,300	870	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.
H = COPC, Evaluated using IEUBK lead model, Max <2XBKGDAVE.

TABLE 4-9

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE SOIL SWMU 1 (μg/kg)
NAS KEY WEST
PAGE 1 OF 2

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	1/8	6.7	5.71	1/7	1,400	235	2,700	1,400	Y	E
4,4'-DDE	3/8	53.3-3.9	12.38	3/7	15.55-1,730	322	1,900	1,730	Y	E
4,4'-DDT	4/8	9.3-2.6	7.62	4/7	5.375-4,700	792	1,900	4,700	Y	B
Aroclor-1260	1/8	69	32.44	2/7	644-900	526	319	900	Y	B
Endrin	0/8	Not detected	-	1/7	19.7	75	2,300	19.7	N	A
Endrin aldehyde	0/8	Not detected	-	1/6	45	88	–	45	Y	F
SEMIVOLATILE ORGANIC COMPOUNDS										
Acetophenone	0/11	Not detected	-	1/10	120	732	780,000	120	N	A
Anthracene	1/11	390	471	2/10	256.75-280	740	2,300,000	280	N	A
Benzo(a)anthracene	0/11	Not detected	-	4/10	160-3420	1014	880	3420	Y	B
Benzo(a)pyrene	0/11	Not detected	-	4/10	200-2185	904	88	2190	Y	B
Benzo(b)fluoranthene	1/11	390	471	4/10	2706830	1384	880	5200	Y	B
Benzo(g,h,i)perylene	0/11	Not detected	-	4/10	180-1940	846	–	1940	Y	F
Benzo(k)fluoranthene	0/11	Not detected	-	3/10	160-410	696	8,800	410	Y	E
Bis(2-ethylhexyl)phthalate	1/11	330	471	4/10	120-2,200	687	46,000	1870	N	A
Chrysene	1/11	280	461	5/10	210-5,435	1,220	88,000	4,910	Y	E
Di-n-butyl phthalate	1/11	82	427	3/10	86-230	622	780,000	230	N	A
Dibenzo(a,h)anthracene	0/11	Not detected	-	4/9	84-604.5	702	88	605	Y	B
Fluoranthene	1/11	660	496	3/6	250-7,100	1,405	310,000	890	N	A
Hexachlorophene	1/2	51	526	4/10	670-890	4,588	2,300	1,590	N	A
Indeno(1,2,3-cd)pyrene	0/11	Not detected	-	4/10	190-1,585	835	880	2,760	Y	B
Phenanthrene	0/11	-	-	5/10	120-2,755	897	-	5,160	Y	F
Pyrene	1/11	470	478	5/10	320-6290	1396	230,000	1	N	A
1,1,2,2-tetrachloroethane	1/12	4	1.96	1/8	1	3	3,200	24.1	N	A
2-butanone	0/10	Not detected	-	1/8	32	10	4,700,000	1	N	A

TABLE 4-9

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE SOIL SWMU 1 (μg/kg)
NAS KEY WEST
PAGE 2 OF 2

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
VOLATILE ORGANIC COMPOUNDS										
2-hexanone	1/12	2	3.92	1/8	1	6	–	230	Y	F
Acetone	1/12	1	3.67	3/8	49-230	44	780,000	9	N	A
Acetonitrile	0/10	Not detected	-	1/5	9	24	47,000	6	N	A
Bis(2-chloroisopropyl)ether	1/10	21	32.1	1/10	6	712	9,100	0.44	N	A
Dibromochloromethane	0/3		-	1/8	0.44	3	7,600	2	N	A
Ethylbenzene	1/12	3.1	1.65	3/8	0.34-2	3	780,000	5,520	N	A
Methylene chloride	6/12	1.1-14	2.8	2/8	10-70	12	85,000	70	N	A
Toluene	1/12	1	1.71	4/8	2-7	4	1,600,000	5.71	N	A
Trans-1,4-dichloro-2-butene	0/12	Not detected	-	1/8	2	7	–	2	Y	F
Xylenes (total)	0/12	Not detected	-	1/8	7	5	16,000,000	5.39	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max <2XBKGDAVE.

TABLE 4-10

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SUBSURFACE SOIL SWMU 1 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Lead	11/12	0.65-48.3	16.8	14/16	0.92-688	96.5	–	688	Y	F

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

Metals were detected in surface soil at SWMU 1 at high frequencies (i.e., detected in greater than 50 percent of the samples analyzed). The maximum and representative concentrations generally exceed risk-based concentrations (RBCs) developed for the land use scenario. Lead will be evaluated quantitatively using the IEUBK model (v. 0.99) and is further discussed in the uncertainty section (Section 4.1.7.6). Pesticides, PAHs, and Aroclor-1260 were detected at relatively high frequencies with maximum and representative concentrations generally exceeding residential RBC screening values. Several organics lacking toxicity values [benzo(g,h,)perylene, 2-hexanone, phenanthrene, and endrin aldehyde] were selected as COPCs and are discussed in the uncertainty section. Trans-1,4-dichloro-2-butene did not have an residential RBC listed for ingestion of soil; however, the chemical does have an inhalation slope factor, so it was included as a COPC and evaluated under the inhalation pathway. Subsurface soil samples were analyzed for lead only. Exposure incurred by an excavation worker potentially contacting lead in subsurface soils will be evaluated qualitatively in the baseline risk assessment.

4.1.7.2.2 Sediment and Surface Water

Several VOCs, SVOCs, pesticides, and metals were detected in one or more of the sediment samples collected at SWMU 1. Acetone, carbon disulfide, bis(2-ethylhexyl)phthalate, chrysene, di-n-butylphthalate, pyrene, and metals were detected in surface water samples collected at SWMU 1. The occurrence and distribution of chemicals in sediment and surface water is presented in Tables 4-11 through 4-14. Summary statistics COPC selection results and representative concentrations for chemicals detected in SWMU 1 in all environmental media are also presented in these tables. The following chemicals were selected as COPCs for SWMU 1 sediment and surface water:

SEDIMENT		SURFACE WATER	
Inorganics	Organics	Inorganics	Organics
Arsenic	Benzo(a)pyrene	Beryllium	Chlorobenzilate
Beryllium	Benzo(b)fluoranthene	Cadmium	Kepone
Copper	Benzo(g,h,i)perylene*	Copper	Isodrin*
Lead*	Chrysene	Lead*	Endrin Aldehyde *
	Dibenz(a,h)anthracene	Mercury	
	Endrin aldehyde*		
	Hexachlorophene		
	Indeno(1,2,3-cd)pyrene		
	3-methylcholanthrene*		

No quantitative toxicity values for these chemicals (*) are listed, therefore, they will be evaluated qualitatively in the uncertainty section.

TABLE 4-11

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SEDIMENT SWMU 1 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	4/4	497-3,350	2,042	7/7	1,040-2,580	1,984	7,800	2,580	N	A
Antimony	0/5	Not detected	–	3/8	1.1-3	3.52	3.1	3	N	A
Arsenic	2/4	1.5-1.6	1.71	5/8	3.15-17.1	6.59	0.43	15.1	Y	C
Barium	5/5	5-15.2	9.88	8/8	5-10.3	6.84	550	8.57	N	A
Beryllium	1/5	0.12	0.11	3/8	0.109-0.28	0.2	0.15	0.28	Y	C
Cadmium	2/5	0.12-0.9	0.42	4/8	0.39-1.8	0.81	3.9	1.8	N	A
Calcium	4/4	223,000-393,000	325,250	7/7	12,000-235,000	79,429	–	235,000	N	D
Chromium	5/5	2.1-11.7	6.94	8/8	4.2-23.8	10.91	39	18.1	N	A
Copper	5/5	0.76-34.6	9.01	8/8	3.3-430	101.31	310	430	Y	C
Cyanide***	0/5	Not detected	–	1/6	3.8	1.64	160	3.8	N	A
Iron	4/4	363-2,600	1,305	7/7	608-2,395	1,043	2,300	1620	N	G
Lead	4/5	5.5-56.5	24.65	8/8	10.4-327	70.70	–	304	Y	F
Magnesium	4/4	4,680-20,000	12,425	7/7	4,820-18,300	12,157	–	18,300	N	D
Manganese	4/4	14.9-38.5	21.95	7/7	4.1-6.5	5.46	180	6.47	N	A
Mercury	0/5	Not detected	–	4/8	0.31-1.9	0.42	2.3	1.9	N	A
Nickel	4/5	0.7-5.5	2.49	7/8	1.8-14.3	4.94	160	10.9	N	A
Potassium	4/4	517-4,180	1,469	6/6	1,060-5,150	3,509	–	5,150	N	D
Selenium	1/5	0.24	1.04	3/8	1.2-3.4	2.39	39	3.4	N	A
Silver	0/5	Not detected	–	1/8	3.5	0.94	39	3.16	N	A
Sodium	4/4	5,500-86,900	28,788	7/7	16,800-108,000	69,464	–	108,000	N	D
Tin	1/2	0.99	2.85	4/4	8.6-72.4	25.50	4,700	72.4	N	A
Vanadium	5/5	2.8-8.9	4.84	8/8	1.9-33.4	18.39	55	33.4	N	A
Zinc	5/5	3.5-58.2	30.40	8/8	19.8-168	72.75	2,300	168	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

***As free cyanide.

TABLE 4-12

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SEDIMENT SWMU 1 (µg/kg)
NAS KEY WEST
PAGE 1 of 2

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
HERBICIDES										
Methyl parathion	0/8	Not detected	-	1/3	35.5	36.32	2,000	35.5	N	A
PESTICIDES/PCBS										
4,4'-DDD	0/2	Not detected	-	3/9	28-210	63.75	2,700	210	N	A
4,4'-DDE	0/2	Not detected	-	7/9	41.9-110	61.00	1,900	110	N	A
4,4'-DDT	0/2	Not detected	-	1/9	27.5	45.17	1,900	27.5	N	A
Beta-BHC	0/2	Not detected	-	1/9	99	23.88	350	99	N	A
Dieldrin	0/2	Not detected	-	1/9	23.25	37.79	40	23.3	N	A
Endosulfan I	0/2	Not detected	-	2/9	22-42.5	36.33	47,000	42.5	N	A
Endosulfan II	0/2	Not detected	-	2/9	133-200	67.92	47,000	2,00	N	A
Endrin aldehyde	0/1	Not detected	-	1/8	37	50.40	–	37	Y	F
Heptachlor	0/2	Not detected	-	1/9	60	17.63	140	60	N	A
SEMIVOLATILE ORGANIC COMPOUNDS										
3-methylcholanthrene	0/5	Not detected	-	1/6	690	1,393	–	690	Y	F
Acetophenone	0/5	Not detected	-	1/6	790	1,543	780,000	790	N	A
Benzo(a)pyrene	0/5	Not detected	-	2/9	780-11,000	2,384	88	11,000	Y	B
Benzo(b)fluoranthene	0/5	Not detected	-	1/9	1,365	1,699	880	1,370	Y	B
Benzo(g,h,i)perylene	0/5	Not detected	-	3/9	515-7,000	1,816	–	4,730	Y	F
bis(2-ethylhexyl)pthalate	1/5	4,500	2,299	1/7	2,000	1809	46000	2,000	N	A
Chrysene	0/5	Not detected	-	2/9	600-14,000	2,786	88,000	14,000	Y	E
Di-n-butyl phthalate	0/5	Not detected	-	1/7	475	1,534	780,000	475	N	A
Dibenzo(a,h)anthracene	0/5	Not detected	-	1/9	610	1,542	88	610	Y	B
Fluoranthene	0/5	Not detected	-	1/9	520	5882	310,000	520	N	A
Hexachlorophene	1/2	820	6,660	3/3	1,200-8,100	4,700	2,300	8,100	Y	B
Indeno(1,2,3-cd)pyrene	0/5	Not detected	-	2/9	710-5,900	1,875	880	4,490	Y	B
Phenanthrene	0/5	Not detected	-	1/9	10000	2,524		10,000	Y	F
Pyrene	0/5	Not detected	-	3/9	680-18,000	3,329	230,000	12,200	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	3/5	4-120	34.3	3/7	49-150	50.29	780,000	150	N	A
Bis(2-chloroisopropyl)ether	0/4	Not detected		1/9	11	1,107	9,100	11	N	A
Carbon disulfide	0/5	Not detected		1/7	13.5	15.80	780,000	13.5	N	A
Chloromethane	0/5	Not detected		1/9	21	19.57	49,000	21	N	A

TABLE 4-12

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SEDIMENT SWMU 1 (µg/kg)
NAS KEY WEST
PAGE 2 of 2

	Background			Site			Residential			
Chemical	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
VOLATILE ORGANIC COMPOUNDS (cont.)										
Dibromochloromethane	0/3	Not detected	-	1/9	1	10	7,600	1	N	A
Dibromomethane	0/5	Not detected	-	1/8	1	9.98	7.5	1	N	A
Methyl methacrylate	0/5	Not detected	-	1/6	3	20.88	630,000	3	N	A
Methylene chloride	2/5	5-20	-	1/9	20	16.64	85,000	20	N	A
Tetrachloroethene	0/5	Not detected	-	1/9	9	8.76	12,000	9	N	A
Toluene	0/5	Not detected	-	1/9	1	10.43	1,600,000	1	N	A
Xylenes (total)	0/5	Not detected	-	1/9	13	13.21	16,000,000	13	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-13

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE WATER SWMU 1 (µg/L) NAS KEY WEST

Chemical	Background			Site			Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	2/5	25-148	37.9	3/5	44.5-242	91.34	3,700	242	N	A
Arsenic	3/7	2.6-5.2	2.94	1/5	1.9752	6.82	0.45	1.98	N	G
Barium	6/6	5.8-16.3	9.05	5/5	2.3-44.5	13.97	260	44.5	N	A
Beryllium	2/7	0.17-0.26	0.27	3/5	0.98-1.2	0.88	0.016	1.20	Y	C
Cadmium	0/7	Not detected	–	2/5	0.185-13.7	3.32	1.8	13.70	Y	C
Calcium	5/5	105,000-326,000	200,200	4/4	231,000-546,000	323,000	–	546,000	N	D
Copper	1/7	2	2.05	3/5	6.85-272	58.05	150	272	Y	C
Iron	2/5	61.6-170	47.2	4/4	39.70-484	160.73	1,100	484	N	A
Lead	0/6	Not detected	–	1/5	377	78.91	–	377	Y	F
Magnesium	5/5	193,000-1,360,000	684000	4/4	919,500-1,600,000	1,232,375	–	1,600,000	N	D
Manganese	2/5	3.2-12.3	3.4	3/5	1.3-12.1	3.42	84	12.10	N	A
Mercury	1/7	0.48	0.123	2/5	0.06-8.4	1.73	1.1	8.4	Y	C
Potassium	5/5	70,600-418,000	227000	4/4	297,000-454,000	373,500	–	454,000	N	D
Sodium	5/5	1,720,000-11,800,000	5,982,000	4/4	7,615,000-13,100,000	9,798,750	–	13,100,000	N	D
Sulfide	2/2	4000-6000	5000	1/2	9500	4800	-	9500	N	D
Thallium	2/7	7.4-12	4.88	1/5	4.3	7.56	0.29	4.3	N	G
Vanadium	2/7	2-2.8	2.26	1/5	1.875	2.60	26	1.88	N	A
Zinc	4/7	1.4-21.5	6.51	4/5	2.10-731	152.76	1,100	731	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-14

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE WATER SWMU 1 (μg/L)
NAS KEY WEST

Chemical	Background: Frequency of Detection	Background: Range of Positive Detection	Background: Average	Site: Frequency of Detection	Site: Range of Positive Detection	Site: Average	Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
PESTICIDES/PCBs										
Endrin aldehyde	0/5	-	-	1/6	0.1	0.08	-	0.1	Y	F
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	0/7	Not detected	-	3/6	3-5	4.33	4.8	5	N	A
Chlorobenzilate	0/7	-	-	1/5	0.5	3.15	0.25	0.5	Y	B
Chrysene	0/7	Not detected	-	1/8	1.6	4.45	9.2	1.6	N	A
Di-n-butyl phthalate	1/7	2	4.64	1/6	1.5	4.42	370	1.5	N	A
Isodrin	0/7	-	-	1/5	0.05	3.02	-	0.05	Y	F
Kepone	0/7	-	-	1/5	0.1	6.08	0.0037	0.01	Y	B
Pyrene	0/7	Not detected	-	1/8	0.95	3.87	110	0.95	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	2/7	4-12	4.14	2/6	5.5-7	5.42	370	6.11	N	A
Carbon disulfide	0/7	Not detected	-	1/6	3.5	2.67	100	3.02	N	A
Methylene chloride	2/7	1-2	1.57	1/7	1	3	4.1	1	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

Metals selected as COPCs for sediment at SWMU 1 were detected in 50 percent or more of the samples analyzed. Maximum and representative concentrations exceeded RBCs for residential soil ingestion. RBCs for soil ingestion are used because RBCs for sediment exposure are not currently published by EPA. Sediment exposures are generally less intensive than soil exposures, thus using residential soil RBCs for sediment ingestion is very conservative. Lead will be evaluated qualitatively in the uncertainty section. Three PAH compounds [benzo(a)pyrene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene and hexachlorophene] were the only organics detected at a maximum concentration exceeding RBCs for residential soil ingestion. Other organics selected as COPCs are either PAH compounds or lack toxicity criteria for quantitative risk analysis. These compounds will be evaluated qualitatively in the uncertainty section.

The metals selected as COPCs for surface water (beryllium, cadmium, copper, lead, mercury) were collected from four or five sample locations. These metals were detected at maximum concentrations exceeding RBCs for tap water ingestion and background concentrations. The RBCs for tap water ingestion were used as a point of comparison because RBCs for typical surface water exposure (i.e., recreational exposures) are not currently published by EPA. It should be noted that surface water exposure (industrial and recreational) are generally less intensive than tap water exposure (i.e., exposures resulting from the typical domestic use of a water supply). Thus, the use of the tap water RBCs to select surface water COPCs is very conservative. Two organics (chlorobenzilate and kepone) detected in the surface water samples were selected as COPCs. These were each detected in one out of five samples. Endrin aldehyde and isodrin lack toxicity values and will be evaluated qualitatively in the uncertainty section.

Methods for selection of COPCs, development of representative concentrations, and other data evaluation procedures are presented in Section 3.2.2 of Appendix G.

4.1.7.3 Toxicity Assessment

The toxicological profiles for selected COPCs at SWMU 1 are presented in Appendix A. All relevant quantitative and qualitative toxicity assessment information and methods are presented in Section 3.2.3 of Appendix G.

4.1.7.4 Exposure Assessment

The COPCs that were selected for each environmental medium sampled at SWMU 1 are presented in Section 4.1.7.2. The potential receptors identified in Appendix G, Section 3.2.4.2 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. Consequently, with the exception of the excavation worker, the potential receptors and exposure pathways presented in Section 3.2.4 of Appendix G were evaluated quantitatively. Although lead was selected as the only COPC for subsurface soils, the IEUBK model (which quantitatively evaluates lead exposure) is applicable only for child receptors. Therefore, no estimated carcinogenic or noncarcinogenic risk is presented for the excavation worker scenario. Exposure parameters, exposure routes, intakes, and other relevant exposure assessment information are presented in Section 3.2.4 of Appendix G. Example calculations for estimated intakes are presented in Appendix A.

4.1.7.5 Risk Characterization

This section presents the results of the quantitative risk assessment. Table 4-15 lists the estimated cumulative carcinogenic and noncarcinogenic risks for future residents, trespasser adults and children, maintenance workers, excavation workers and occupational workers at SWMU 1. The total risk for each exposure route and the cumulative risk across all exposure pathways are provided. The risks associated with a particular COPC are provided in the risk assessment spreadsheets in Appendix A. This section discusses the human health risk in four parts:

- Carcinogenic risks
- Noncarcinogenic risks
- The results from the evaluation of lead in surface soils using the IEUBK model

Additionally, a comparison of groundwater results to screening criteria and a special note concerning fish are presented.

4.1.7.5.1 Carcinogenic Risks

The estimated carcinogenic risk for the hypothetical future residents is 3E-04, which is greater than the EPA "target risk range" of 1E-04 to 1E-06. Dermal contact with surface soil for the future resident has a incremental cancer risk of 1E-04. This exposure route contributes the most to the cumulative carcinogenic risk for the future resident. The dermal contact with COPC route is associated with high uncertainty based on the absorption efficiency ($ABSEFF_{oral}$) presented in Appendix G, Section 3.2.3.4. The 1E-04 to 1E-06 risk range is often used by EPA in setting standards and criteria and in determining the need for environmental remediation. The principal COPCs contributing to this cancer risk are

TABLE 4-15

CUMULATIVE RISKS
SWMU 1*
NAS KEY WEST
PAGE 1 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
Surface Soil						
Dermal contact	1E-04	5E-06	4E-06	3E-06	NA	3E-05
Incidental ingestion	7E-05	1E-06	2E-06	9E-07	NA	8E-06
Inhalation of fugitive dust	9E-08	5E-10	7E-10	7E-10	NA	2E-08
Subtotal of Media	2E-04	6E-06	6E-06	4E-06	NA	4E-05
Subsurface Soil						
Dermal contact	NA	NA	NA	NA	**	NA
Incidental ingestion	NA	NA	NA	NA	**	NA
Inhalation of fugitive dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
Sediment						
Dermal contact	6E-05	2E-05	1E-05	NA	NA	NA
Incidental ingestion	5.1E-05	6E-06	6E-06	NA	NA	NA
Subtotal of Media	1E-04	3E-05	2E-05	NA	NA	NA
Surface Water						
Dermal contact	6E-07	1E-07	1E-01	NA	NA	NA
Incidental ingestion	2E-06	3E-07	3E-07	NA	NA	NA
Subtotal of Media	3E-06	4E-07	4E-07	NA	NA	NA
Total	3E-04	4E-05	3E-05	4E-06	**	4E-05
HAZARD INDEX						
Surface Soil						
Dermal contact	7E-01	3E-02	5E-02	2E-02	NA	1E-01
Incidental ingestion	4E+00	3E-02	6E-02	2E-02	NA	2E-01
Inhalation of fugitive dust	1E-03	4E-06	9E-06	4E-06	NA	9E-05
Subtotal of Media	5E+00	6E-02	1E-01	4E-02	NA	3E-01
Subsurface Soil						
Dermal contact	NA	NA	NA	NA	**	NA
Incidental ingestion	NA	NA	NA	NA	**	NA
Inhalation of fugitive dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
Sediment						
Dermal contact	3E-01	9E-02	12E-01	NA	NA	NA
Incidental ingestion	3E-01	2E-02	3E-02	NA	NA	NA
Subtotal of Media	6E-01	1E-01	1E-01	NA	NA	NA

TABLE 4-15

CUMULATIVE RISKS
SWMU 1*
NAS KEY WEST
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX (cont.)						
Surface Water						
Dermal contact	8E-02	7E-03	8E-04	NA	NA	NA
Incidental ingestion	2E-01	1.4E-02	3E-02	NA	NA	NA
Subtotal of Media	3E-01	2E-02	3E-02	NA	NA	NA
Total	6E+00	2E-01	2E-01	4E-02	**	3E-01

* = Chemical-specific risks are presented in Appendix A.
** = Either no COPCs were selected or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not applicable, pathway is not applicable for the respective media.

Aroclor-1260 (surface soil), benzo(a)pyrene (surface soil and sediment), and arsenic (surface soil and sediment). Arsenic is a major contributor to risk in surface soil; however, it was detected at levels that were just above background. Benzo(a)pyrene is a major contributor to the risk in surface soil and sediment. The estimated carcinogenic risks for trespasser adults (4E-05), trespasser adolescents (3E-05), maintenance workers (4E-06), and occupational workers (4E-05) are within the EPA target risk range. The principal COPC contributing to these cancer risks was benzo(a)pyrene (surface soil and sediment). No quantitative carcinogenic risk was estimated for excavation workers because lead was the only COPC selected for subsurface soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.1.7.5.2 Noncarcinogenic Risks

The cumulative hazard index (HI) for the hypothetical future resident (6E+00) exceeds 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. The principal COPCs contributing to the noncarcinogenic risk are iron [surface soils, HQ = 1.27], antimony (surface soils, HQ = 0.49), arsenic (surface soils, HQ = 0.67), cadmium (surface soils, HQ = 0.42), and mercury (surface soils, HQ = 0.28). The target organs for these chemicals are as follows: antimony (heart), cadmium (kidney), arsenic (skin), iron (pancreas and liver), and mercury (kidney and central nervous system). Iron in surface soil is the primary noncarcinogenic risk driver for the future resident (via ingestion) at SWMU 1. In general, iron was 10 times higher than background levels and may be associated with past site activities, which include disposal and burning of waste oil, hydraulic fluid, paint thinner, and solvents. However, there is a high uncertainty associated with iron's oral reference dose (RfD). No COPCs other than iron have HQs greater than 1.0 for the surface soil ingestion exposure route and no HI based on the same target organ would be above 1.0. The HQs for all other receptors at SWMU 1 are less than or equal to 1.0. No quantitative noncarcinogenic risk was estimated for excavation workers because lead was the only COPC selected for subsurface soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.1.7.5.3 IEUBK Lead Results

The IEUBK Lead Model (v.0.99) was used to characterize potential effects associated with exposure to media containing lead. The model was run two ways: using the representative concentration and using the average concentration. The purpose of this was to give the risk manager a range of risks based on a conservative exposure (using the representative concentration) and an average exposure (using the average concentration). 1.) Using the representative concentration - Based on model results, 64.0 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This exceeds the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL (EPA, 1994). The model inputs assumed were the default parameter values, 740 mg/kg lead in site-related soils, and 74.4 µg/L lead in groundwater. 2.) Using the average concentration - Based on model results, 4.1 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL (EPA, 1994). The model inputs assumed were default parameter values, 111.23 mg/kg lead in site-related soils, and 22.3 µg/L lead in groundwater. The IEUBK histograms for background and SWMU 1 exposures are presented in Appendix A.

4.1.7.5.4 Groundwater and the Quantitative Risk Assessment

Groundwater was not evaluated as part of the baseline human health risk assessment (HHRA) because it is classified as Class G-III, unpotable water by FDEP. As discussed in Section 3 and in Section 3.2.2.2 of Appendix G, groundwater obtained from the surficial aquifer at Key West has a high salinity. The public water supply obtained from the mainland is officially designated as the only potable source. No freshwater public or registered domestic wells exist, although domestic wells are reportedly used for purposes such as flushing water. Although treatment could possibly be used to improve water quality, the local water authority has authority to regulate all potable supplies in the Keys.

A preliminary comparison of unfiltered groundwater concentrations at the SWMU 1 versus tap water RBCs (EPA, 1995b) and MCLs (EPA, 1995c) is presented in Tables 4-16 and 4-17 for inorganics and organics, respectively. The results of this preliminary comparison for SWMU 1 are presented in this section.

The maximum values of methylene chloride, benzene, vinyl chloride, antimony, arsenic, mercury, and thallium exceeded both their respective MCL and RBC values. Mercury and antimony are considered major exceedances, but the data present anomalous trends. For mercury, all but one of the detections above the MCL were associated with a single sampling event (1986). For antimony, positive detections were obtained from only the 1990 and 1993 sampling events. (See Section 4.1.6 for further discussion of trends for these two metals.) Arsenic concentrations exceeded tap water RBCs; however, this is not uncommon for unfiltered groundwater. Only one arsenic result exceeded the MCL. Thallium was detected only in two out of 18 samples; therefore, widespread contamination is not apparent and the observed trend does not correlate with any particular well location. Methylene chloride exceeded the RBC in four samples collected in 1986; however, this trend was not repeated in later sampling and the compound is considered a common laboratory contaminant. Benzene exceeded the tap water RBC in all 3 samples in which it was detected, but only the maximum concentration of benzene (25 µg/L) exceeded the MCL.

TABLE 4-16

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLS AND TAP WATER RBCS INORGANICS IN GROUNDWATER SWMU 1 (µg/L) NAS KEY WEST

	Background			Site						
Chemical	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	MCL*	Maximum Exceeds MCL?	Tap water RBC**	Maximum Exceeds RBC?
Aluminum	0/3	Not detected	–	8/11	405-75,800	10887	NL	NA	37,000	Y
Antimony	0/5	Not detected	–	15/27	32.6-251	90.38	6	Y	15	Y
Arsenic	3/6	4.1-11.9	4.33	15/27	4.40-95	18.01	50	Y	0.045	Y
Barium	6/6	6.6-19.5	13.88	23/23	7.95-228	46.77	2,000	N	2,600	N
Beryllium	0/6	Not detected	–	4/27	0.935-1.10	1.21	4	N	0.016	Y
Cadmium	0/6	Not detected	–	2/27	5.60-9.70	3	5	Y	18	N
Calcium	3/3	114,000-244,000	181,000	11/11	260,000-8,880,000	3,290,486	NL	NA	NL	NA
Chromium	2/6	0.71-13	4.09	13/27	1.20-106	17.35	100	Y	180	N
Copper	0/6	Not detected	–	17/27	1.20-73	25.29	1,300	N	1,500	N
Cyanide	2/3	2.4-5.525	2.76	4/17	1.10-310	56.46	200	Y	730	N
Iron	2/3	76.9-97.4	62.6	9/11	320-20,600	5,972.52	NL	NA	11,000	Y
Lead	1/5	2.5	1.19	12/27	13.50-74.40	22.36	15	Y	NL	NA
Magnesium	3/3	123,750-825,250	433,000	11/11	211,000-1,390,000	965,220.5	NL	NA	NL	NA
Manganese	2/3	3.9-10.3	4.87	10/11	2-321	60.15	NL	NA	180	Y
Mercury	1/6	0.13	0.08	9/27	0.3-66	8.94	2	Y	11	Y
Nickel	0/13	Not detected	-	3/27	29.6-45.6	12.77	100	N	700	N
Potassium	3/3	38,850-181,750	119,000	11/11	66,900-425,000	270,742.5	NL	NA	NL	NA
Sodium	3/3	982,250-6,615,000	3,670,000	11/11	1,770,000-12,300,000	8,074,309	NL	NA	NL	NA
Thallium	1/6	4.925	2.52	2/27	10.90-20.10	12.08	2	Y	2.9	Y
Tin	0/3	Not detected	–	2/12	82.30-107	27.86	NL	NA	22,000	N
Vanadium	0/6	Not detected	–	7/23	10.95-106	15.24	NL	NA	260	N
Zinc	3/6	3.42-15.3	4.94	17/27	6-221	36.27	NL	NA	11,000	N

NA = Not applicable.
NL = Not listed
*MCL = Maximum Contaminant Level (EPA, 1995c).
**RBC = Risk-Based Concentration (EPA, 1995b).

TABLE 4-17

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLS AND TAP WATER RBCS ORGANICS IN GROUNDWATER SWMU 1 (µg/L) NAS KEY WEST PAGE 1 OF 2

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
HERBICIDES										
Methyl parathion	0/5	Not detected	–	1/4	0.02	0.39	NL	NA	9.1	N
PESTICIDES/PCBs										
Aldrin	0/6	Not detected	–	1/24	0.036	0.04	NL	NA	0.004	Y
SEMIVOLATILE ORGANIC COMPOUNDS										
1,2-dichlorobenzene	0/4	Not detected	–	1/27	1.2	2.85	600	N	270	N
2-methylnaphthalene	0/4	Not detected	–	1/13	268	25.37	NL	NA	1,500	N
4-chloroaniline	0/4	Not detected	–	1/13	4.25	5.06	6	N	NL	NA
Acenaphthene	0/4	Not detected	–	2/24	3.4-18	2.68	NL	NA	2,200	N
Acenaphthylene	0/4	Not detected	–	3/24	4.6-8	2.38	NL	NA	NL	NA
Bis(2-ethylhexyl)phthalate	0/4	Not detected	–	3/17	2-4	3.69	NL	NA	4.8	N
Chrysene	0/4	Not detected	–	1/24	1.1	1.62	NL	NA	9.2	N
Dibenzofuran	0/4	Not detected	–	1/13	8	6	NL	NA	150	N
Diethyl phthalate	0/4	Not detected	–	1/17	1.2	2.96	NL	NA	29,000	N
Fluoranthene	0/4	Not detected	–	2/24	8	2.66	NL	NA	1,500	N
Fluorene	0/4	Not detected	–	3/24	1-36	5.62	NL	NA	1,500	N
Naphthalene	1/4	2	4.09	2/24	34-725	51.87	NL	NA	1,500	N
Phenanthrene	0/4	Not detected	–	3/24	1.6-51	5.35	NL	NA	NL	NA
Pyrene	0/4	Not detected	–	4/24	1.1-8	2.01	NL	NA	1,100	N
VOLATILE ORGANIC COMPOUNDS										
1,1,1-trichloroethane	0/3	Not detected	–	1/27	0.8	1.19	200	N	1,300	N
1,2-dichloroethene (total)	0/1	Not detected	–	3/8	1-8	3.56	70	N	55	N
2-butonone	2/3	7-32	14.7	1/13	2-2	4.19	NL	NA	1,900	N
4-methyl-2-pentanone	0/4	Not detected	-	1/13	23	6.0	NL	NA	2,900	N
Acetone	1/3	5	5	3/13	1-11	4.12	NL	NA	3,700	N
Bromomethene	0/4	Not detected	–	1/27	5	2.41	NL	NA	8.7	N
Benzene	0/3	Not detected	–	3/27	1-25	2.49	5	Y	0.36	Y
Carbon disulfide	0/3	Not detected	–	9/13	1.1-7	3.27	NL	NA	1,000	N
Cis-1,2-dichloroethene	0/3	Not detected	–	3/11	1.4-5.8	1.34	70	N	61	N
~~Chlorobenzene~~	~~0/3~~	~~Not detected~~	~~–~~	~~4/27~~	~~1-5.2~~	~~1.77~~	~~NL~~	~~NA~~	~~39~~	~~N~~
Chloromethane	0/4	Not detected	–	1/27	2-2	2.22	NL	NA	1.4	Y
Ethylbenzene	0/3	Not detected	–	2/27	6-7.9	1.94	700	N	1,300	N

TABLE 4-17

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLS AND TAP WATER RBCS ORGANICS IN GROUNDWATER SWMU 1 (µg/L) NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
VOLATILE ORGANIC COMPOUNDS (cont.)										
Idomethane	0/4	Not-detected	–	3/5	2-3	2.8	NL	NA	NL	NA
m-xylene	0/0	Not detected	–	1/4	15	4.13	10,000	N	1,400	N
Methylene chloride	2/3	1	1.5	12/27	1-9.7	4.41	5	Y	4.1	Y
o+p xylenes	0/0	Not detected		1/4	20	5.38	10,000	N	520	N
Styrene	0/3	Not detected	–	1/13	2	2.23	100	N	1,600	N
Toluene	0/4	Not detected	–	4/27	1.2-11	2.19	1,000	N	750	N
Trans-1,2-dichloroethene	0/2	1.2	2.07	2/19	2.5-6	1.18	70	N	120	N
Vinyl chloride	0/3	Not detected	–	7/27	1-16	3.23	2	Y	0.019	Y
Xylenes (total)	0/3	Not detected	–	1/23	4.8	1.88	10,000	N	12,000	N

NA = Not applicable.
NL = Not listed
*MCL = Maximum contaminant level (EPA, 1995c).
**RBC = Risk-based concentration (EPA, 1995b).

Vinyl chloride was detected near the center of the site in two wells in several sampling rounds at levels ranging from 2 to 16 µg/L, which exceeds both the MCL and tap water RBC. This contaminant was not detected in 1996 sampling. Considering the interim removal action at SWMU 1, it is unlikely that significant contaminant migration will occur, given the localized and trace levels present.

The maximum values of cadmium, chromium, cyanide, and lead exceeded their respective MCL values. Lead was detected in 11 out of 25 samples at concentrations greater than twice the MCL. Chromium was only detected in one out of 22 samples greater than the MCL and cadmium in two out of 20 samples. Cyanide exceeded the MCL in one out of eight samples. However, it should be noted that these inorganics present in groundwater at the ppb level are nonetheless far lower in concentration relative to the minerals which contribute to high groundwater salinities.

The maximum values of aluminum, chloromethane, aldrin, beryllium, iron, and manganese exceeded their respective RBC values. Beryllium was detected in three out of 18 samples significantly above the RBC. Iron was detected at a level slightly exceeding the RBC in only one out of nine samples. Manganese was detected in only one out of seven samples at a level greater than the RBC. Aldrin was detected at a level greater than the RBC in one out of 15 samples. This substance did not occur in other media samples with any trend or regularity. Chloromethane was detected at a level greater than the RBC in one out of 27 samples.

4.1.7.5.5 Fish and the Quantitative Risk Assessment

Fish and shellfish at SWMU 1 were not considered a human health concern because intensive fish collection activities did not reveal any edible fish. A more complete discussion of this subject is presented in Section 3.2.2.3 of Appendix G.

4.1.7.6 Uncertainties for SWMU 1

Beyond the uncertainties associated with the human health risk assessment process discussed in Appendix G, the following uncertainties should be considered in any evaluation of SWMU 1 risk assessment results:

- The uncertainty associated with the dermal exposure is high because of the derivation of the dermal reference dose (See Appendix G, Section 3.2.3.4). Dermal exposure is a primary contributor to the cumulative cancer risk (via surface soils) for the future residential receptors. The uncertainty associated with the dermal exposure route may overestimate the risk at SWMU 1.

- Arsenic is a major contributor to the cumulative carcinogenic risks in surface soil, but arsenic was detected at levels in SWMU 1 that slightly exceed background levels. The inclusion of arsenic as site-related surface soil COPC could overestimate the quantitative risk at SWMU 1 for the future residential receptor.

- Use of residential RBCs (sediment) and tap water RBCs (surface water) probably influences the selection of COPCs at the site by potential designated chemicals as COPCs that do not contribute significantly to the quantitative risk at SWMU 1 (i.e., PAHs in sediment). This bias is based on sediment and surface water exposure that is generally well above intakes a receptor would be exposed to under a true residential soil and groundwater exposure pathway.

- Several chemicals, notably pesticides in surface soils and sediment, did not have listed toxicity values for use in the quantitative risk assessment; therefore, no risks were estimated for exposure to the COPCs. These chemicals generally had low frequencies of detection (i.e., generally less than 20 percent of the samples analyzed had detections) and low detected concentrations (as compared to other chemicals in the same class, e.g., pesticides).

- Lead was determined to be a COPC in subsurface soil, sediment, and surface water at SWMU 1. Lead exposure to subsurface soil, sediment, and surface water is not estimated under the IEUBK Lead Model for the baseline human health risk assessment at SWMU 1. This probably underestimates the risks to potential receptors exposed to lead in subsurface soil, sediment, and surface water, especially to residential children (surface water and sediment). Exposure to lead in surface water and sediment by residential children is lower than exposure to lead in surface soil at SWMU 1. Therefore, the risks are expected to be lower than those results estimated by exposure to surface soils at SWMU 1 using the IEUBK Lead model. It is generally desirable to avoid contact with lead for all potential receptors, especially for young children.

4.1.7.7 Chemicals of Concern and Remedial Goal Options

This section presents the selected chemicals of concern and remedial goal options for SWMU 1.

4.1.7.7.1 <u>Selection of Chemicals of Concern</u>

From the COPCs chosen for each medium in the baseline risk assessment, a subset of chemicals, called COCs, was selected for the evaluation of remedial clean-up goal options (RGOs). At SWMU 1, COCs were included in the RGO evaluation only if they exceeded ARARs or criteria which were to be considered

(TBC) [as in the case of mercury, which exceeded surface water ambient water quality criteria (AWQC)] or, as with other COCs, because the COC contributed significant cancer risk (above 1E-06) or a non-cancer HQ above 0.1 in conjunction with a receptor scenario having a total risk (combined across pathways) above the level of concern (1E-04 cancer risk or HI of 1.0). Section 3.2.7 of Appendix G further describes the ARARs, TBCs, and risk-based criteria used in selecting COCs [RCRA Corrective Action Levels, FDEP Soil Cleanup Goals (SCGs), and AWQC]. Note that antimony has an HI greater than 0.1, but is not included as a COC because its target organ (heart, circulatory system) is not one of the organ systems associated with the other COCs. The COCs selected at SWMU 1 are as follows:

Surface Soils - Selection Based on Future Resident Exposure Scenario

- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Iron
- Lead - Selection Based on FDEP SCG
- Manganese
- Mercury
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Aroclor-1260
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Dibenz(a,h)anthracene
- Indeno(1,2,3-cd)pyrene

Surface Soils - Selection Based on Occupational Worker Exposure Scenario

- Lead - <u>Selection Based on FDEP SCGs</u>

Sediment - Selection Based on Future Resident (Recreational Use)

- Arsenic
- Lead - <u>Selection Based on FDEP SCGs</u>
- Benzo(a)pyrene
- Dibenzo(a,h)anthracene
- Hexachlorophene
- Indeno(1,2,3-cd)pyrene

Surface Water

- Beryllium - <u>Selection Based on Future Resident (Recreational Use)</u>
- Mercury - <u>Selection Based on AWQC for Aquatic Organisms</u>

4.1.7.7.2 Remedial Goal Options

RGO cleanup levels based on generic FDEP and RCRA TBCs for COCs in surface soils and sediment (presuming sediment might become future surface soil) are listed in Table 4-18 for residential and occupational worker exposure scenarios. Table 4-19 lists RGOs for COCs in surface water based on Federal AWQC (relevant to exposure via consumption of aquatic organisms). The RGOs developed according to site-specific baseline risk assessment assumptions are listed for a range of three target risk levels in Table 4-20 (surface soil - future resident), Table 4-22 (sediment - future resident), and Table 4-23 (surface water). These site-specific RGOs are intended to provide the risk manager with a range of values that can facilitate the evaluation of potential remediation strategies. However, the generic TBCs and AWQC are also important inputs for use in decisionmaking. Further explanation of the derivations and assumptions related to these RGOs is presented in Section 3.2.7 of Appendix G.

4.1.7.8 Conclusions

The primary objectives of investigation at SWMU 1 were to identify existing nature and extent of contamination (after interim remedial action) in the on-site media, to provide a baseline human health risk assessment of COPCs identified in those media, and to perform an ecological risk assessment.

Noncarcinogenic and carcinogenic human health risks were estimated for potential current (trespasser, maintenance worker, and occupational worker) and hypothetical future (residents and excavation worker) receptors.

COPCs in SWMU 1 media were not present at sufficient concentrations to cause adverse noncarcinogenic health effects to any current potential receptors and the future excavation worker. The cancer risks estimated for the current potential receptors and the future excavation worker were within the 1E-04 to 1E-06 target risk range, often used by EPA in setting standards and criteria and in evaluating the need for environmental remediation.

COPCs at SWMU 1 were present at concentrations indicating that adverse noncarcinogenic health effects might occur under conditions evaluated in this baseline human health risk assessment for the hypothetical future resident. Additionally, cancer risks for this receptor were estimated at levels exceeding 1E-04. Furthermore, based on the results of the IEUBK Lead Model (v. 0.99), significant increases (greater than EPA's cutoff of five percent) in the population of hypothetical future residential children with blood lead

TABLE 4-18

TO BE CONSIDERED RGO CRITERIA FOR SOILS/SEDIMENT AT SWMU 1 NAS KEY WEST

COC	RCRA Subpart S Action Levels (mg/kg)	FDEP Residential Soil Cleanup Goals (mg/kg)	FDEP Industrial Soil Cleanup Goals (mg/kg)
INORGANICS			
Arsenic	80	0.7	3.1
Beryllium	0.2	0.2	1
Cadmium	40	37	600
Chromium	420	290	430
Copper	NA	NA	NA
Iron	NA	NA	NA
Lead	400	500	1,000
Manganese	10,000	370	5,500
Mercury	20	20.6	721
PESTICIDES/PCBs			
4,4'-DDD	3	4.5	17
4,4'-DDE	2	3	11
4,4'-DDT	2	3.1	12
Aroclor-1260	0.09	0.9	3.5
SEMIVOLATILE ORGANIC COMPOUNDS			
Benzo(a)anthracene	1	1.4	4.9
Benzo(a)pyrene	0.1	0.1	0.5
Benzo(b)fluoranthene	1	1.4	5
Dibenzo(a,h)anthracene	0.1	0.1	0.5
Hexachlorophene	20	NA	NA
Indeno(1,2,3-cd)pyrene	1	1.4	5

TABLE 4-19

TO BE CONSIDERED RGO CRITERIA FOR SURFACE WATER AT SWMU 1 NAS KEY WEST

COC	Human Health Criteria Organism Consumption (µg/L)
Beryllium	NL
Mercury	0.15

NL - Not Listed.

TABLE 4-20

RGOS DEVELOPED FOR PROTECTION OF FUTURE RESIDENT EXPOSURE TO SURFACE SOIL AT SWMU 1 NAS KEY WEST

COC	Carcinogenic Cleanup Levels			Noncarcinogenic Cleanup Levels		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
INORGANICS (mg/kg)						
Arsenic	0.09	0.88	8.8	0.92	9.2	28
Beryllium	0.14	1.4	14	-	-	-
Cadmium	-	-	-	3	26	79
Chromium	-	-	-	37	369	1,100
Copper	-	-	-	299	2,990	8,970
Iron	-	-	-	2,000	22,000	67,000
Manganese	-	-	-	37	374	1,100
Mercury	-	-	-	2	22	67
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	460	4,600	46,000	-	-	-
4,4'-DDE	320	3,200	32,000	-	-	-
4,4'-DDT	310	3,100	31,000	1,300	13,000	39,000
Aroclor-1260	13	130	1,300	-	-	-
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Benzo(a)anthracene	870	8,700	87,000	-	-	-
Benzo(a)pyrene	88	880	8,800	-	-	-
Benzo(b)fluoranthene	881	8,800	88,000	-	-	-
Dibenzo(a,h)anthracene	88	880	8,800	-	-	-
Indeno(1,2,3-cd)pyrene	1,500	15,000	150,000	-	-	-

TABLE 4-21

THIS TABLE NO LONGER NEEDED.

TABLE 4-22

RGOs DEVELOPED FOR PROTECTION OF FUTURE RESIDENT - EXPOSURE TO SEDIMENT (RECREATIONAL USE) - SWMU 1 NAS KEY WEST

COC	Carcinogenic Cleanup Levels			Noncarcinogenic Cleanup Levels		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
INORGANICS (mg/kg)						
Arsenic	0.31	3.1	31	3.2	32	97
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Benzo(a)pyrene	210	2,100	21,000	–	–	–
Dibenzo(a,h)anthracene	210	2,100	21,000	–	–	–
Hexachlorophene	–	–	–	2,800	28,000	84,000
Indeno(1,2,3-cd)pyrene	3,000	30,000	300,000	–	–	–

TABLE 4-23

RGOs DEVELOPED FOR PROTECTION OF
FUTURE RESIDENT - EXPOSURE TO SURFACE WATER (RECREATIONAL USE) - SWMU 1
NAS KEY WEST

COC	Carcinogenic Cleanup Levels			Noncarcinogenic Cleanup Levels		
	1.00E-06	1.00E-05	1.00E-04	0.1	1	3
INORGANICS (µg/L)						
Beryllium	0.60	6.0	60	-	-	-
Mercury	-	-	-	8.3	83	250

levels above 10 µg/dL are expected based on exposure to lead in groundwater and surface soil at SWMU 1. Arsenic, benzo(a)pyrene, and Aroclor-1260 are the main contributors to the carcinogenic risk and iron and manganese are the main contributors to the noncarcinogenic risk. Arsenic concentrations in surface soil slightly exceed background levels. PAHs are present in surface soils at concentrations that could result from the possible disposal of asphalt at the site. A black tarry substance collected from SWMU 1 and analyzed by BEI had a composition consistent with materials used in asphalt production. Iron and manganese may not be associated with any past site-related activity and could represent non-anthropogenic levels for SWMU 1.

The future land uses planned for this site (i.e., military base with restricted access or zoned future limited access because of existing conditions, e.g., areas near the active airstrip) do not include residential land use for the foreseeable future; therefore, the potential risks estimated using COPCs at SWMU 1 may never be realized. Based on this and the uncertainties associated with COPCs found at SWMU 1, a no further action (NFA) for all media evaluated at SWMU 1 in this baseline human health risk assessment is recommended.

4.1.8 <u>Ecological Risk Assessment</u>

This section discusses the results of the ecological risk assessment performed at SWMU 1 through a discussion of the problem formulation, effects characterization, exposure assessment and risk characterization.

4.1.8.1 Problem Formulation

This section presents the ecological problem formulation through a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of Ecological Contaminants of Potential Concern (ECPCs), assessment and measurement endpoints, and the conceptual site model.

4.1.8.1.1 <u>Habitat Types and Ecological Receptors</u>

Section 4.1.1 (see Figure 4-10), describes the physical setting at SWMU 1. The disposal and burning area is relatively flat and characterized by exposed sand and soil with scattered patches of vegetation. The site is bordered to the south and east by a mangrove swamp dominated by red and black mangroves. Grassy areas containing some small trees, which provide habitat for terrestrial receptors, are west of Stone Road. The area west of Stone Road provides habitat for the Lower Keys marsh rabbit, which is listed as endangered by the U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission. The middle and southern portions of the site are frequently inundated with water. The exact source of the water is unclear, but it appears to be mainly from the ponding of rainwater. However, the site occasionally receives some tidal flooding, and the salinity is high in all onsite surface water. Water is less ephemeral at the southern end of the site near the mangroves, as evidenced by the presence of small fish, piscivorous birds, and aquatic invertebrates.

There are three small, shallow ponded areas in the eastern portion of the site within the mangrove swamp. These areas are approximately 15 feet wide, 2 to 3 feet deep, and range from approximately 40 feet to 80 feet in length. They appear to be borrow pits, and were presumably excavated when the site was used for waste disposal. Exposed metal and glass is abundant in and near these ponds. Minnow-sized fish were present in these areas, and were collected from the ponds for tissue analysis.

Ecological receptors at the site include small fish, arboreal and wading birds, and presumably reptiles and amphibians. Raccoon tracks were abundant throughout the site. The endangered Lower Keys marsh rabbit probably uses portions of the site. Wading birds such as the little blue heron (*Egretta caerulea*) and tricolored heron (*E. tricolor*), which are state-listed as Species of Special Concern, forage on the site. The aquatic habitats are not expected to be used by bald eagles or ospreys, since the only fish available are small minnows.

4.1.8.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

The contaminant sources at SWMU 1 are the former disposal and burn areas. The contaminant release pathways from these areas include combustion, volatilization, wind erosion, overland runoff, and infiltration of contaminants. Constituents in the site soil can volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust can be generated during ground-disturbing activities, such as construction or excavation. These contaminants are dispersed in the surrounding environment and transported to downwind locations where they can repartition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition. However, most of the site is frequently inundated with water or is part of the mangrove swamp, minimizing the airborne transport of contaminants, through gravitational settling, precipitation, and deposition. However, most of the site is frequently inundated with water or is part of the mangrove swamp, minimizing the airborne transport of contaminants.

Precipitation runoff can carry constituents to nearby surface waters, sediments, and surface soils, primarily to surface water and sediments in the mangrove swamp. Infiltrating precipitation can cause the

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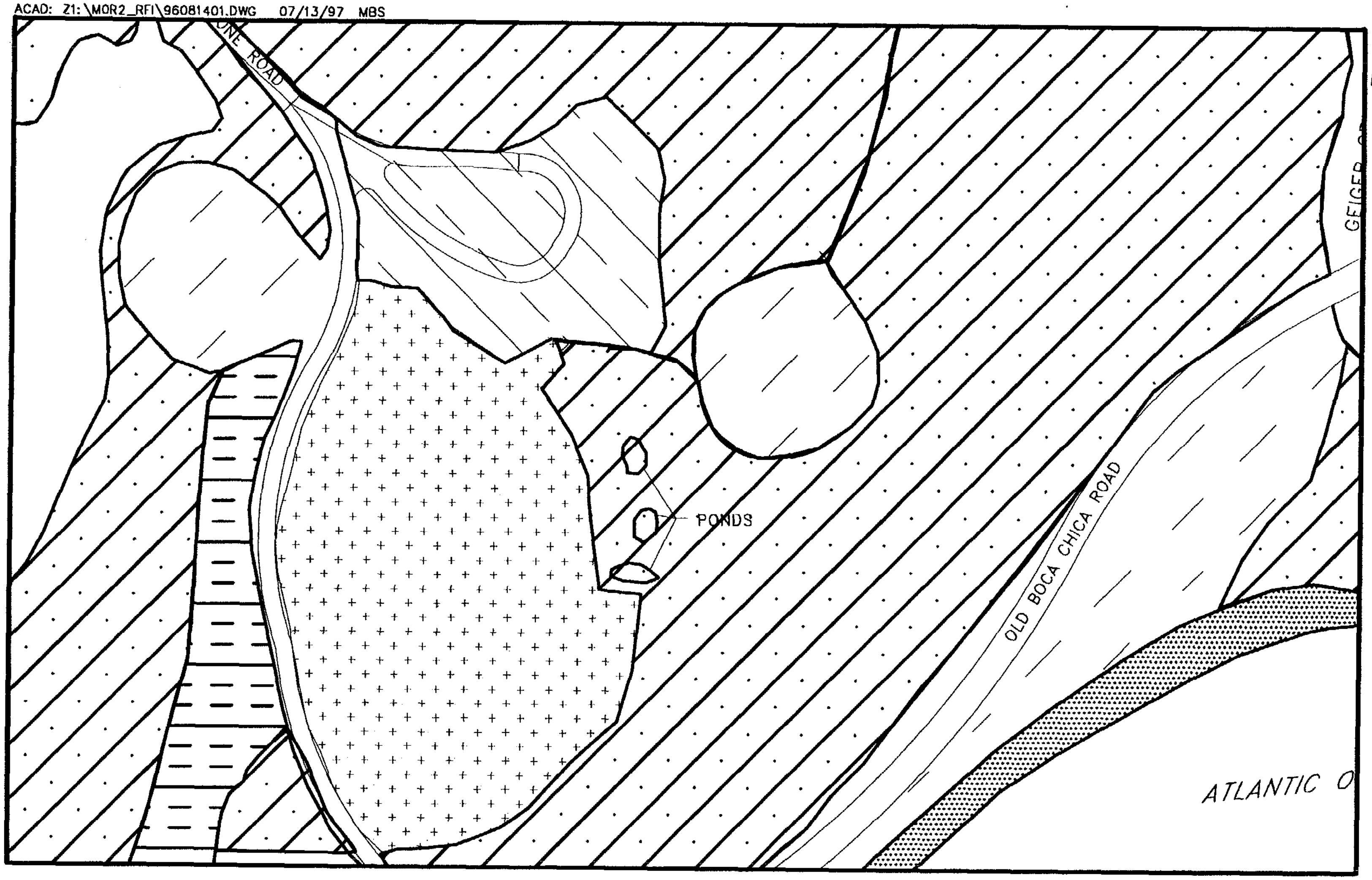

Brown & Root Environmental

0 200 400

SCALE IN FEET

LEGEND

- UPLAND/FILLED (MOWED OR EXOTICS)
- MIXED MANGROVE
- BUTTONWOOD WETLAND
- MANGROVE/ BUTTONWOOD/MARSH TRANSITION ZONE
- BEACH DUNE
- POND/ NATURAL
- RECENTLY EXCAVATED (INTERIM REMEDIATION)

FIGURE 4–10. HABITATS AT SWMU 1 OPEN DISPOSAL AREA

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY:	SCALE:	DATE:	REV:
MBS	–	08/08/96	0
CHECKED BY:	CONTRACT NO.:	FILE NAME:	
MLW	–	KEY WEST/T1/96081401.DWG	

contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in a soil are expected to migrate at a slower rate. On infiltrating the soil column and reaching the water table, a contaminant can be carried with the flow of groundwater to downgradient locations. Groundwater at the site is shallow and probably is connected hydrologically to surface water in the mangrove swamp; contaminants can be deposited subsequently in sediment or can accumulate in the tissues of aquatic organisms.

4.1.8.1.3 Exposure Routes

Terrestrial receptors at SWMU 1 can be exposed to soil contaminants through the incidental ingestion of soil and contaminated food items. Animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation. Terrestrial receptors can also come to contact with contaminants in surface water by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. In addition, a high salt content in onsite surface water precludes the use of the water for drinking. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatile constituents are present in some site soils, soil-bound contaminant resuspension can occur, and combustion can release contaminants into the air at SWMU 1. However, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. In addition, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Aquatic and terrestrial organisms inhabiting SWMU 1 and the mangrove swamp can be exposed to contaminants through direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semiaquatic organisms can also be exposed to constituents in contaminated groundwater that flows into surface water.

4.1.8.1.4 Selection of Ecological Contaminants of Potential Concern

ECPCs include all the contaminants detected during current and previous sampling of surface water, groundwater, sediment, and surface soil at SWMU 1. However, calcium, iron, magnesium, potassium, and sodium were excluded as ECPCs in all media because they are essential nutrients that are toxic only in extremely high concentrations. In addition, inorganic contaminants whose maximum detected concentration is less than two times the average background concentration were excluded. This comparison to background is recommended by EPA (1996) because concentrations of inorganics can be naturally elevated and not due to base-related contaminant releases.

4.1.8.1.5 Assessment and Measurement Endpoints

A detailed description of assessment and measurement endpoints for this investigation is presented in Section 3.3 .1.1.6 of Appendix G.

4.1.8.1.6 Conceptual Site Model

The conceptual model is designed to identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the site were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Figure 4-11 shows the conceptual model for SWMU 1.

4.1.8.2 Ecological Effects Characterization

Ecologically based benchmarks, concentrations of contaminants in various media protective of ecological receptors, were selected to screen against exposure point concentrations of ECPCs in groundwater, surface water, sediment, and soil to determine if they qualify as ecological contaminants of concern (ECCs) at SWMU 1. Brief descriptions of each ECC are included in Appendix D - Toxicity Profiles. Groundwater contaminant concentrations were compared to surface-water benchmarks for fresh water. Terrestrial plant benchmarks were obtained to screen potential risks to plants from soil contaminants. Contaminant intake doses for the Lower Keys marsh rabbit were modeled, and estimated doses were compared to RfDs, which are doses above which potential risks might be present (Appendix E). Groundwater, surface-water, sediment, terrestrial plant, and surface soil benchmarks are listed in Appendix G, as are RfDs used in food-chain modeling. Section 3.3.1.2 of Appendix G discusses benchmark selection.

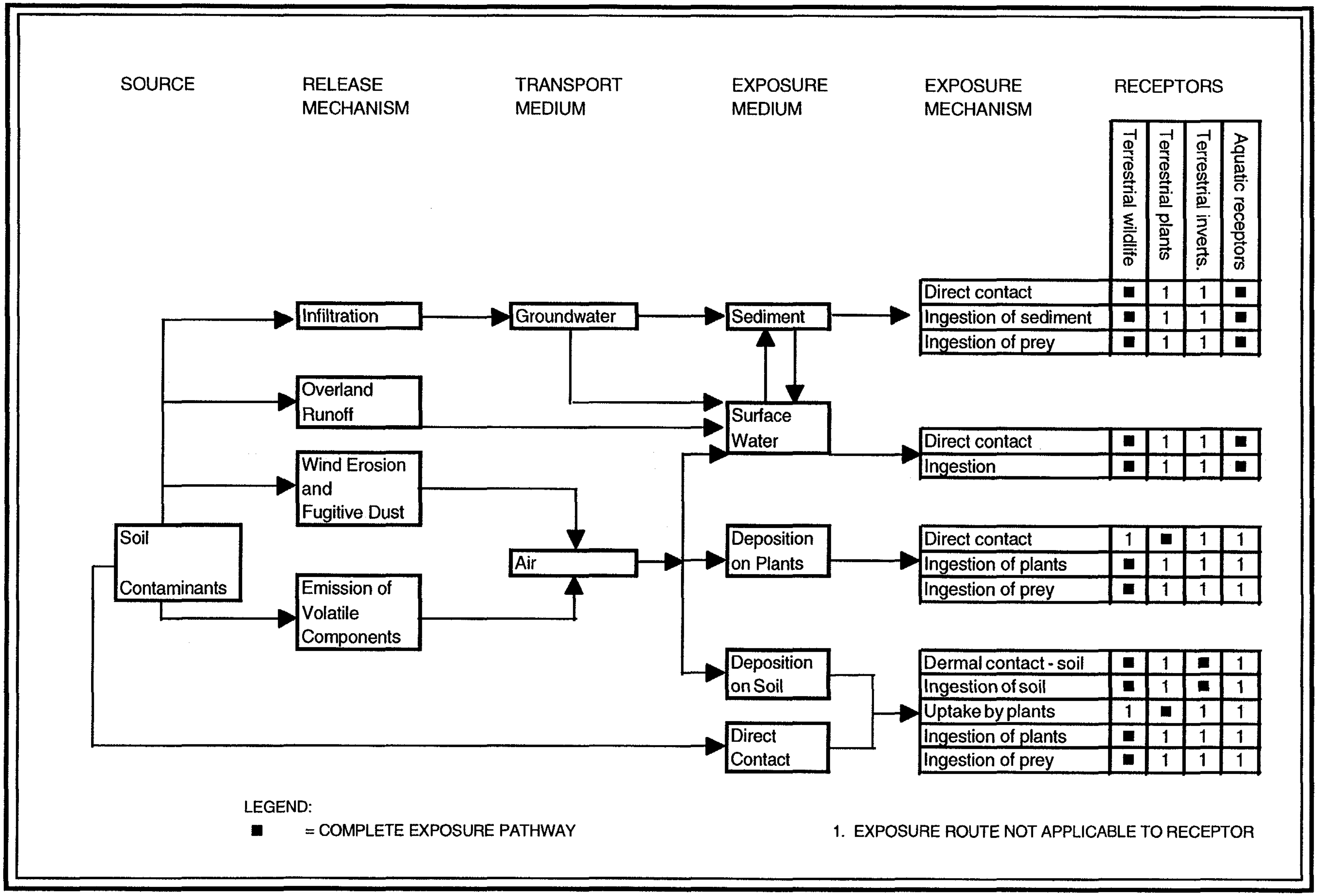

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Figure 4-11. Conceptual Site Model - SWMU 1, NAS Key West, Boca Chica Key, Florida

Toxicity tests were performed using surface water, sediment, and soil collected from SWMU 1 (Appendix F). The toxicity of surface water was evaluated using the silverside minnow, mytilid mussel, and sea urchin, while the toxicity of sediment was evaluated using the mysid shrimp. Soil toxicity was evaluated using the earthworm. To investigate bioaccumulation of contaminants by soil-dwelling organisms at SWMU 1, earthworms were reared in soil samples for 14 days beyond the base 14-day toxicity test described in Section 1.4.2 of Appendix G. Following the 28-day study, earthworm samples were subjected to laboratory analysis for metals. Rapid decomposition of mortalities precluded the collection of earthworm tissue in quantities sufficient for analyses of other contaminants. Results of the toxicity tests in surface water, sediment, and soil samples collected from SWMU 1 were compared to results in concurrently tested laboratory control samples.

Fish were collected from small ponded areas at the site and analyzed for volatile organic compounds, semivolatile compounds, pesticides, PCBs, and metals. Concentrations of contaminants detected in the fish were compared to concentrations in fish collected at background sites (Table 4-24) and to benchmark concentrations considered to be protective of piscivorous receptors (Table 4-25).

4.1.8.3 Exposure Assessment

This section presents the ecological exposure assessment for SWMU 1 through a discussion of exposure point contaminant concentrations and ecological dose calculations.

4.1.8.3.1 Exposure Point Contaminant Concentrations

Only those analytical results from sampling locations that were outside the area of the soil excavated during the interim remedial action were used in the current ecological risk assessment. The maximum detected contaminant concentrations in groundwater, surface water, sediment, and soil were used as representative exposure point concentrations for screening against benchmark values. Background values were obtained from several locations at NAS Key West. Background sampling is described in detail in Appendix J.

IT Corporation conducted a preliminary ecological risk assessment at SWMU 1 as part of the RFI/RI activities at NAS Key West (IT Corporation, 1994). That assessment compared the maximum contaminant concentrations detected in surface-water, groundwater, and surface soil samples taken as part of the RFI/RI field activities to selected background values and various benchmark values. Contaminants were eliminated as potential COCs if they failed to meet several criteria, including a

TABLE 4-24

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 1 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 1 OF 2

	SWMU 1			BACKGROUND			
	Frequency of Detection	Range of Detected Values(1)	Average(2)	Frequency of Detection	Range of Detected Values	Average(2)	Average of all Background Values for All Species(2)
INORGANICS							
ARSENIC							**1.64**
Crested goby	1/1	0.58	0.58	0/4			
Fat sleeper	2/2	0.79 - 2	1.40	NC			
Sailfin molly	5/5	0.58 - 0.79	0.71	2/12	0.89 - 1.10	0.25	
Sheepshead minnow	2/2	0.37 - 0.42	0.40	3/6	0.56 - 0.72	0.49	
BARIUM							**1.01**
Crested goby	1/1	0.74	0.74	4/4	0.67 - 0.89	0.74	
Fat sleeper	2/2	1.1 - 1.2	1.15	NC			
Sailfin molly	5/5	6.1 - 9.4	8.34	12/12	1.90 - 3.90	2.88	
Sheepshead minnow	2/2	4.6 - 4.9	4.75	6/6	0.91 - 2.00	1.17	
COPPER							**3.13**
Crested goby	1/1	0.85	0.85	2/4	0.70 - 16.30	4.37	
Fat sleeper	2/2	2.9 - 3.1	3	NC			
Sailfin molly	5/5	3.6 - 5	4.1	12/12	1.40 - 10.20	4.16	
Sheepshead minnow	2/2	5.3 - 7	6.15	6/6	2.80 - 10.30	5.43	
LEAD							**1.18**
Crested goby	1/1	0.29	0.29	1/4	0.16	0.09	
Fat sleeper	2/2	1.4 - 2.3	1.85	NC			
Sailfin molly	5/5	1.8 - 4.9	3.04	9/12	0.14 - 5.30	0.60	
Sheepshead minnow	2/2	5.4 - 8.6	7	6/6	0.33 - 11.90	7.97	
SELENIUM							**0.35**
Crested goby	1/1	0.34	0.34	4/4	0.26 - 0.37	0.32	
Sailfin molly	2/5	0.29	0.26	11/12	0.24 - 0.42	0.32	
ZINC							**32.4**
Crested goby	1/1	34.5	34.5	4/4	29.4 - 45.0	38.4	
Fat sleeper	2/2	63.9 - 75.6	69.75	NC			
Sailfin molly	5/5	30.4 - 58.9	38.76	12/12	13.6 - 45.4	31.06	
Sheepshead minnow	2/2	47.8 - 66.3	57.05	6/6	23.3 - 45.5	37.02	
PESTICIDES/PCBs							
4, 4'-DDD							**4.30**
Crested goby	1/1	7.9	7.9	0/4			
Fat sleeper	2/2	9 - 9.1	9.05	NC			
Sailfin molly	5/5	14.6 - 33	22.66	10/12	1.8 - 16.6	3.26	
Sheepshead minnow	2/2	14.6 - 19.6	17.1	6.6	1.7 - 13.1	7.93	
4, 4'-DDE							**44.3**
Crested goby	1/1	155	155	4/4	5.8 - 7.0	6.4	
Fat sleeper	2/2	162 - 196	179	NC			
Sailfin molly	5/5	60.2 - 118	87.48	12/12	10.3 - 68.3	25.3	
Sheepshead minnow	2/2	59.7 - 60.6	60.15	6/6	21.2 - 34.1	26.0	
4, 4'-DDT							**0.58**
Sailfin molly	1/5	1.5	1.36	1/2	2.00	0.65	
ALDRIN							**ND**
Sailfin molly	1/5	1.4	1.34	0/12			
AROCLOR-1260							**49.3**
Crested goby	1/1	73	73	0/4			
Fat sleeper	2/2	48 - 58	53	NC			
Sailfin molly	4/5	41 - 81	56.2	8/12	29.0 - 60.0	33.3	

TABLE 4-24

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 1 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 2 OF 2

	SWMU 1			BACKGROUND			
	Frequency of Detection	Range of Detected Values(1)	Average(2)	Frequency of Detection	Range of Detected Values	Average(2)	Average of all Background Values for All Species(2)
PESTICIDES/PCBs (cont.)							
DELTA-BHC							**ND**
Fat sleeper	1/2	3.3	2.15	NC			
Sailfin molly	2/5	3.3 - 7.6	2.84	0/12			

1 Values for metals are mg/kg (ppm); values for pesticides and PCBs are µg/kg (ppb).
2 One half the detection limit used for all non-detected values.
NC = Species not collected from background sites during January 1996 sampling.
ND = Not detected in any background sample.

Note: Samples consisted of crested goby (Lophogobius cyprinoides), fat sleeper (Dormitator maculatus), sailfin molly (Poecilia latipinna) and sheepshead minnow (Cyprinodon variegatus). All samples were analyzed for volatiles, semi-volatiles, metals, pesticides, and PCBs

TABLE 4-25

CONTAMINANT CONCENTRATIONS IN FISH TISSUE PROTECTIVE OF PISCIVOROUS RECEPTORS NAS KEY WEST

Ecological Contaminant of Potential Concern[1]	Contaminant Concentration	Source
INORGANICS (mg/kg WET WEIGHT)		
Arsenic	N.A.[2]	
Barium	N.A.	
Copper	N.A.	
Lead	2.0	Fish tissue concentration protective of marine animals (Maddock and Taylor, 1980)
Mercury	0.1 1.1	Fish concentration protective of piscivorous birds (Eisler, 1987) Fish concentration protective of piscivorous mammals (Eisler, 1987)
Selenium	0.75	Piscivorous fish and wildlife criterion (Lemly, 1996)
Silver	N.A.	
Zinc	N.A.	
PESTICIDES/PCBs (µg/kg WET WEIGHT)		
4,4'-DDD	200	Criterion for protection of sensitive wildlife species (Newell et. al., 1987)
4,4'-DDE	200	Criterion for protection of sensitive wildlife species (Newell et. al., 1987)
4,4'-DDT	200	Criterion for protection of sensitive wildlife species (Newell et. al., 1987)
Aldrin	120 22	Non-carcinogenic piscivorous wildlife criterion (Newell et. al., 1987) 1 in 100 cancer risk level for piscivorous wildlife (Newell et. al., 1987)
Alpha-BHC	100 510	Non-carcinogenic piscivorous wildlife criterion (Newell et. al., 1987) 1 in 100 cancer risk level for piscivorous wildlife (Newell et. al., 1987)
Aroclor-1260	100	Total PCB criteria for piscivorous birds and mammals (IJCUSC, 1988)
	130 110	Non-carcinogenic piscivorous wildlife criterion (Newell et. al., 1987) 1 in 100 cancer risk level for piscivorous wildlife (Newell et. al., 1987)
	3000	Fish concentration that is protective of piscivorous birds and mammals (Eisler, 1986)
Beta-BHC	100 510	Non-carcinogenic piscivorous wildlife criterion (Newell et. al., 1987) 1 in 100 cancer risk level for piscivorous wildlife (Newell et. al., 1987)
Delta-BHC	100 510	Non-carcinogenic piscivorous wildlife criterion (Newell et. al., 1987) 1 in 100 cancer risk level for piscivorous wildlife (Newell et. al., 1987)

1 Detected in at least one fish tissue sample collected from SWMUs 1, 2, or 3.
2 N.A. = Not Available.

maximum concentration less than a conservative benchmark, low mobility or bioaccumulation potential, and detection in less than 5 percent of samples. Also, the maximum contaminant concentrations in selected media were multiplied by bioconcentration factors (BCFs) to obtain predicted contaminant concentrations in prey, which were compared to reference toxicity values from the literature for selected receptor species. The results of the preliminary ecological risk assessment for SWMU 1 are presented in Section 4.1.8.4.1.

4.1.8.3.2 Dose Calculations

The potential risks to ecological receptors resulting from exposure to SWMU 1-related contaminants were also evaluated by estimating the total contaminant dose that an organism inhabiting the site might receive for each contaminant and comparing that dose to doses above which adverse effects might occur (RfDs). Section 3.3.2.1.2 of Appendix G provides a detailed description of dose calculations for this food-chain modeling and lists the exposure parameters used for the Lower Keys marsh rabbit, which was selected as the representative terrestrial receptor for food-chain modeling at SWMU 1.

4.1.8.4 Risk Characterization

This section presents the results and a discussion of the ecological risks at SWMU 1.

4.1.8.4.1 Results

The results of the ecological risk characterization at SWMU 1 are presented in this section with a discussion of the results from the Phase I and Phase II ecological screening assessments, food-chain modeling for the Lower Keys marsh rabbit, toxicity assessment, and tissue analyses.

4.1.8.4.1.1 Phase I - Ecological Screening Assessment

The Phase I preliminary ecological risk assessment identified antimony, chromium, lead, tin, vanadium, and chrysene as COCs in groundwater. In surface water, antimony, barium, cadmium, copper, lead, mercury, and zinc were identified as COCs. Several metals, PAHs, and pesticides were COCs in soils and sediments. The Phase I assessment also indicated that piscivores appeared to be at risk from all types of COCs that bioaccumulate in food items, and fish were at greatest risk from inorganics in surface water. Incidental ingestion of soil posed high potential risk from all types of COCs to terrestrial receptors, but contaminated forage appeared to present only moderate potential risks.

4.1.8.4.1.2 Phase II - Ecological Screening Assessment

In SWMU 1 groundwater, several inorganics exceeded benchmarks and were retained as ECCs; these included aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, cyanide, lead, manganese, mercury, thallium, vanadium, and zinc (Table 4-26). The organic groundwater contaminants m-, o-, and p-xylene, total xylenes, acenapthene, fluorene, naphthalene, phenanthrene, bis(2-ethylhexyl)phthalate, and aldrin exceeded benchmark values and were retained as ECCs. Tin and several organics were conservatively retained as ECCs because no suitable benchmarks were available.

In SWMU 1 surface waters, beryllium, cadmium, copper, lead, manganese, mercury, and zinc exceeded benchmark values and were retained as inorganics ECCs (Table 4-27). Carbon disulfide was the only organic compound that exceeded its benchmark in surface water. Several VOCs and pesticides were retained as ECCs in surface water since no suitable benchmarks were available. In sediments, the inorganics arsenic, cadmium, silver, and zinc exceeded the most conservative benchmarks and were retained as ECCs, but did not exceed less conservative benchmarks (Table 4-28). Copper, lead, and mercury exceeded both most and less conservative benchmarks, and cyanide exceeded the only sediment benchmark available. Several organics in sediments exceeded the most conservative benchmarks available and were retained as ECCs, and also exceeded less conservative benchmarks; these included 4,4'-DDD, 4,4'-DDE, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, phenanthrene, and pyrene. The organics 4,4'-DDT, bis(2-ethylhexyl)phthalate, benzo(b)fluoranthene, dieldrin, fluoranthene, and indeno(1,2,3-cd)pyrene exceeded most conservative benchmarks and were retained as ECCs, but did not exceed less conservative benchmarks. In addition, acetone, carbon disulfide, beta-BHC, endosulfan I and II, endrin aldehyde, and heptachlor exceeded the only benchmarks available. Aluminum, beryllium, selenium, tin, vanadium, and several organics were conservatively retained as ECCs because no suitable sediment benchmarks were available.

In SWMU 1 soils, the inorganics aluminum, chromium, copper, lead, manganese, mercury, tin, and zinc exceeded benchmarks and were retained as ECCs (Table 4-29). A number of organic contaminants exceeded benchmark values, including 4,4'-DDT and its degradation products and several PAHs. Antimony, beryllium, and several organics were conservatively retained as ECCs because no suitable surface soil benchmarks were available. For the terrestrial plant exposure scenario, the inorganics aluminum, antimony, cadmium, chromium, copper, lead, mercury, nickel, silver, vanadium, and zinc exceeded benchmarks and were retained as ECCs (Table 4-30). Terrestrial plant benchmarks were not available for most organic contaminants, although no organic contaminants for which benchmarks were available had HQs greater than 1.0. Contaminants with no suitable terrestrial plant benchmarks were conservatively retained as ECCs.

TABLE 4-26

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 1
NAS KEY WEST
PAGE 1 OF 3

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
HERBICIDES						
Methyl parathion	1/24	ND	0.02	0.04	0.5	Eliminated - does not exceed threshold
INORGANICS						
Aluminum	8/11	ND	405 - 75,800	87	871	Retained - HQ > 1
Antimony	15/27	ND	32.6 - 251	4,300	0.06	Eliminated - does not exceed threshold
Arsenic	15/27	4.33	4.40 - 94.5	50	1.9	Retained - HQ > 1
Barium	23/23	13.88	7.95 - 228	3.9	58.5	Retained - HQ > 1
Beryllium	4/27	ND	0.94 - 1.10	0.13	8.5	Retained - HQ > 1
Cadmium	2/27	ND	5.6 - 9.7	0.66	14.7	Retained - HQ > 1
Chromium	13/27	4.09	1.2 - 106	11	9.6	Retained - HQ > 1
Copper	17/27	ND	1.2 - 72.8	6.54	11.1	Retained - HQ > 1
Cyanide	4/17	2.76	1.1-310	5.2	59.6	Retained - HQ > 1
Lead	12/27	1.19	13.5 - 74.4	1.32	56.4	Retained - HQ > 1
Manganese	10/11	4.82	2.0 - 321	80	4.0	Retained - HQ > 1
Mercury	9/27	0.08	0.3 - 66.0	0.012	5,500	Retained - HQ > 1
Nickel	3/27	ND	29.6 - 45.6	87.7	0.51	Eliminated - does not exceed threshold
Thallium	2/27	3	10.9 - 20.1	6.3	3.2	Retained - HQ > 1
Tin	2/12	ND	82.3 - 107	NA		Retained - no suitable threshold was available
Vanadium	7/23	ND	10.95 - 106.0	19	5.6	Retained - HQ > 1
Zinc	17/27	4.94	6.0 - 221	58.9	3.8	Retained - HQ > 1
PESTICIDES/PCBs						
Aldrin	1/24	ND	0.04	0.00014	285	Retained - HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
1,2-dichlorobenzene	1/27	ND	1.2	15.8	0.08	Eliminated - does not exceed threshold
2-methylnapthalene	1/13	ND	268	NA		Retained - no suitable threshold was available
4-chloroaniline	1/13	ND	4.25	NA		Retained - no suitable threshold was available
Acenapthene	2/24	ND	3.4 - 18	17	1.06	Retained - HQ > 1
Acenapthylene	3/24	ND	4.6 - 8.0	NA		Retained - no suitable threshold was available
Bis(2-ethylhexyl)phthalate	3/17	ND	2.0 - 4.0	0.3	13.3	Retained - HQ > 1

TABLE 4-26

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 1
NAS KEY WEST
PAGE 2 OF 3

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (cont.)						
Chrysene	1/24	ND	1.1	NA		Retained - no suitable threshold was available
Dibenzofuran	1/13	ND	8.0	20	0.4	Eliminated - does not exceed threshold
Diethyl phthalate	1/17	ND	1.2	521	0.00	Eliminated - does not exceed threshold
Fluoranthene	2/24	ND	3.0 - 8.0	39.8	0.20	Eliminated - does not exceed threshold
Fluorene	3/24	ND	1.0 - 36	3.9	9.2	Retained - HQ > 1
Naphthalene	2/24	4.09	34 - 725	62	11.7	Retained - HQ > 1
Phenanthrene	3/24	ND	1.6 - 51	6.3	8.09	Retained - HQ > 1
Pyrene	4/24	ND	1.1 - 8.0	NA		Retained - no suitable threshold was available
VOLATILE ORGANIC COMPOUNDS						
1,1,1-trichloroethane	1/27	ND	0.8	62	0.01	Eliminated - does not exceed threshold
1,2-dichloroethene (total)	3/8	ND	1.0 - 8.0	NA		Retained - no suitable threshold was available
2-butanone	1/13	14.7	2.0	NA		Retained - no suitable threshold was available
4-methyl-2-pentanone	1/13	ND	23.0	NA		Retained - no suitable threshold was available
Acetone	3/13	5	1.0 - 11.0	NA		Retained - no suitable threshold was available
Benzene	3/27	ND	1.1 - 25.0	71.28	0.4	Eliminated - does not exceed threshold
Bromoethane	1/27	ND	5.0	NA		Retained - no suitable threshold was available
Carbon disulfide	9/13	ND	1.0 - 7.0	NA		Retained - no suitable threshold was available
Chlorobenzene	4/27	ND	1.0 - 5.2	195	0.03	Eliminated - does not exceed threshold
Chloromethane	1/27	ND	2.0	470.8	0.004	Eliminated - does not exceed threshold
Cis-1,2-dichloroethene	3/11	ND	1.4 - 5.8	NA		Retained - no suitable threshold was available
Ethylbenzene	2/27	ND	6.0 - 7.9	453	0.02	Eliminated - does not exceed threshold
Iodomethane	3/5	ND	2.0 - 3.0	NA		
m-xylene	1/4	ND	15.0	1.8	8.33	Retained - HQ > 1
Methylene chloride	12/27	1.5	1.0 - 9.7	1,930	0.00	Eliminated - does not exceed threshold
o+p-xylenes	1/4	ND	20	1.8	11.1	Retained - HQ > 1
Styrene	1/13	ND	2.0	NA		
Toluene	4/27	ND	1.2 - 11	130	0.08	Eliminated - does not exceed threshold
Trans-1,2-dichloroethene	2/19	ND	2.5 - 6	NA		Retained - no suitable threshold was available

TABLE 4-26

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 1
NAS KEY WEST
PAGE 3 OF 3

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
VOLATILE ORGANIC COMPOUNDS (cont.)						
Vinyl chloride	7/27	ND	1 - 16	NA		Retained - no suitable threshold available
Xylenes (total)	1/23	ND	4.8	1.8	2.67	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-27

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE WATER - SWMU 1
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Aluminum	3/5	37.93	44.5 - 242	1,500	0.16	Eliminated - does not exceed threshold
Arsenic	1/5	2.94	1.98	50	0.04	Eliminated - does not exceed 2 X background
Barium	5/5	9.05	2.30 - 44.5	10,000	0.004	Eliminated - does not exceed 2 X background
Beryllium	3/5	0.27	0.98 - 1.2	0.13	9.23	Retained - HQ > 1
Cadmium	2/5	ND	0.19 - 13.7	9.30	1.47	Retained - HQ > 1
Copper	3/5	2.05	6.85 - 272	2.40	113.3	Retained - HQ > 1
Lead	1/5	ND	377	5.60	67.3	Retained - HQ > 1
Manganese	3/5	3.40	1.3 - 12.1	10	1.21	Retained - HQ > 1
Mercury	2/5	0.12	0.08 - 8.4	0.025	336	Retained - HQ > 1
Thallium	1/5	4.88	4.3	6.30	0.68	Eliminated - does not exceed 2 X background
Vanadium	1/5	2.26	1.88	10,000	0.0002	Eliminated - does not exceed 2 X background
Zinc	4/5	6.51	2.1 - 731	86	8.5	Retained - HQ > 1
PESTICIDE/PCB						
Endrin aldehyde	1/6	ND	0.10	NA		Retained - no suitable threshold available
Chlorobenzilate	1/5	ND	0.50	NA		Retained - no suitable threshold available
Isodrin	1/5	ND	0.05	NA		Retained - no suitable threshold available
Kepone	1/5	ND	0.10	NA		Retained - no suitable threshold available
SEMIVOLATILE ORGANIC COMPOUNDS						
Bis(2-ethylhexyl)phthalate	3/6	ND	3.0 - 5.0	360	0.01	Eliminated - does not exceed threshold
Carbon disulfide	1/6	ND	3.5	2	1.75	Retained - HQ > 1
Chrysene	1/8	ND	1.6	31	0.05	Eliminated - does not exceed threshold
Di-n-butyl phthalate	1/6	4.64	1.5	3.4	0.44	Eliminated - does not exceed threshold
Pyrene	1/8	ND	0.95	11,000	0.00009	Eliminated - does not exceed threshold
VOLATILE ORGANIC COMPOUNDS						
Acetone	2/6	4.14	5.50 - 7.0	9,000,000	7.7E-07	Eliminated - does not exceed threshold
Methylene chloride	1/7	1.57	1.00	1,930	0.0005	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-28

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 1
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPC)	Frequency of Detection	Average Background Concentration	Range of Detection Values	Ecological Threshold Value[1]	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	7/7	2,041.75	1,040 - 2,580	NA		Eliminated - does not exceed 2 X background
Antimony	3/8	ND	1.1 - 3	12	0.25	Eliminated - does not exceed threshold
Arsenic	5/8	1.71	3.15 - 17.1	7.24/70	2.36/0.24	Retained - HQ > 1
Barium	8/8	9.88	5.0 - 10.3	40	0.26	Eliminated - does not exceed 2 X background
Beryllium	3/8	0.11	0.11 - 0.28	NA		Retained - no suitable threshold was available
Cadmium	4/8	0.42	0.39 - 1.8	0.68/9.6	2.66/0.19	Retained - HQ > 1
Chromium	8/8	6.94	4.2 - 23.8	52.3	0.46	Eliminated - does not exceed threshold
Copper	8/8	9.01	3.3 - 430	18.7/270	22.99/1.59	Retained - HQ > 1
Cyanide	1/6	ND	3.8	0.1	38	Retained - HQ > 1
Lead	8/8	24.65	10.4 - 327	30.2/218	10.83/1.5	Retained - HQ > 1
Manganese	7/7	21.95	4.1 - 6.5	460	0.01	Eliminated - does not exceed 2 X background
Mercury	4/8	ND	0.31 - 1.9	0.13/0.71	14.62/2.68	Retained - HQ > 1
Nickel	7/8	2.49	1.8 - 14.3	15.9	0.9	Eliminated - does not exceed threshold
Selenium	3/8	1.04	1.2 - 3.4	NA		Retained - no suitable threshold was available
Silver	1/8	ND	3.5	0.73/3.7	4.77/0.95	Retained - HQ > 1
Tin	4/4	2.85	8.6 - 72.4	NA		Retained - no suitable threshold was available
Vanadium	8/8	4.84	1.9 - 33.4	NA		Retained - no suitable threshold was available
Zinc	8/8	30.4	19.8 - 168	124/410	1.35/0.41	Retained - HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	3/9	ND	28 - 210	3.3/46	63.6/4.57	Retained - HQ > 1
4,4'-DDE	7/9	ND	41.9 - 110	1.22/27	90.16/4.07	Retained - HQ > 1
4,4'-DDT	1/9	ND	27.5	2.07/46	13.29/0.60	Retained - HQ > 1
Beta-BHC	1/9	ND	99	5	19.80	Retained - HQ > 1
Dieldrin	1/9	ND	23.25	0.72/95	32.3/0.25	Retained - HQ > 1
Endosulfan I	2/9	ND	22 - 42.5	5.4	7.87	Retained - HQ > 1
Endosulfan II	2/9	ND	133 - 200	5.4	37.04	Retained - HQ > 1
Endrin aldehyde	1/8	ND	37	3.5	10.57	Retained - HQ > 1
Heptachlor	1/9	ND	60	4.9	12.24	Retained - HQ > 1
HERBICIDES (µg/kg)						
Methyl parathion	1/3	ND	35.5	NA		Retained - no suitable threshold was available

TABLE 4-28

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 1
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPC)	Frequency of Detection	Average Background Concentration	Range of Detection Values	Ecological Threshold Value[1]	Hazard Quotient	Reason for Retention or Elimination as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
3-methylcholanthrene	1/6	ND	690	NA		Retained - no suitable threshold was available
Acetophenone	1/6	ND	790	NA		Retained - no suitable threshold was available
Benzo(a)pyrene	2/9	ND	780 - 11,000	88.8/1,600	123.87/6.88	Retained - HQ > 1
Benzo(b)fluoranthene	1/9	ND	1,365	330/1,700	4.14/0.80	Retained - HQ > 1
Benzo(g,h,i)perylene	3/9	ND	515 - 7,000	330/1,700	21.21/4.12	Retained - HQ > 1
Bis(2-ethylhexyl phthalate)	1/7	2.3	2,000	182/8.9E+08	11.0/2.2E-06	Retained - HQ > 1
Chrysene	2/9	ND	600 - 14,000	384/2,800	36.46/5.00	Retained - HQ > 1
Di-n-butyl phthalate	1/7	ND	475	11000	0.04	Eliminated - does not exceed threshold
Dibenzo(a,h)anthracene	1/9	ND	610	6.22/260	98.07/2.35	Retained - HQ > 1
Fluoranthene	1/9	ND	520	113/5,100	4.60/0.10	Retained - HQ > 1
Hexachlorophene	3/3	6,660	1,200 - 8,100	NA		Retained - no suitable threshold was available
Indeno(1,2,3-cd)pyrene	2/9	ND	710 - 5,900	655/9,600	9.01/0.61	Retained - HQ > 1
Phenanthrene	1/9	ND	10,000	86.7/330	115/30.3	Retained - HQ > 1
Pyrene	3/9	ND	680 - 18,000	153/2,600	117.65/6.92	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetone	3/7	34.3	49 - 150	64	2.34	Retained - HQ > 1
Bis(2-chloroisopropyl)ether	1/9	ND	11	NA		Retained - no suitable threshold was available
Carbon disulfide	1/7	ND	13.50	13	1.04	Retained - HQ > 1
Chlorodibromomethane	1/9	ND	1	NA		Retained - no suitable threshold was available
Chloromethane	1/9	ND	21	NA		Retained - no suitable threshold was available
Dibromomethane	1/8	ND	1	NA		Retained - no suitable threshold was available
Methylene chloride	1/9	0.0076	20.00	427	0.047	Eliminated - does not exceed threshold
Methyl methacrylate	1/6	ND	3	NA		Retained - no suitable threshold was available
Tetrachloroethene	1/9	ND	9	530	0.02	Eliminated - does not exceed threshold
Toluene	1/9	ND	1	670	0.001	Eliminated - does not exceed threshold
Xylenes (total)	1/9	ND	13	25	0.52	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

1 When two values are presented, the left value is the most conservative available and the right value is a less conservative value, if available. In these instances, two HQ values are presented. Contaminants were retained as final ECPCs if the most conservative ET value available was exceeded.

TABLE 4-29
ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 1
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	7/7	2,130	1540 - 7,810	600	13.02	Retained - HQ > 1
Antimony	4/8	0.43	1.3 - 21.7	NA		Retained - no suitable threshold was available
Arsenic	5/8	1.40	1.2 - 6.4	60	0.11	Eliminated - does not exceed threshold
Barium	8/8	11.0	9.7 - 99.6	440	0.23	Eliminated - does not exceed threshold
Beryllium	3/8	0.05	0.13 - 0.2	NA		Retained - no suitable threshold was available
Cadmium	6/8	0.17	0.96 - 11.2	20	0.56	Eliminated - does not exceed threshold
Chromium	8/8	6.22	7.5 - 184	0.4	460	Retained - HQ > 1
Cobalt	6/8	0.34	0.45 - 4.6	200	0.02	Eliminated - does not exceed threshold
Copper	8/8	5.28	4.3 - 407	50	8.14	Retained - HQ > 1
Lead	54/58	16.80	0.47 - 740	500	1.48	Retained - HQ > 1
Manganese	7/7	19.40	19.1 - 467	100	4.67	Retained - HQ > 1
Mercury	6/8	0.03	0.12 - 6.2	0.1	62	Retained - HQ > 1
Nickel	7/8	1.63	3.3 - 50.2	200	0.25	Eliminated - does not exceed threshold
Selenium	3/8	0.72	0.24 - 0.61	70	0.009	Eliminated - does not exceed 2 X background
Silver	6/8	ND	0.58 - 7.6	50	0.15	Eliminated - does not exceed threshold
Tin	4/4	1.94	3.6 - 11.8	0.89	13.26	Retained - HQ > 1
Vanadium	8/8	3.71	3.35 - 11.1	20	0.56	Eliminated - does not exceed threshold
Zinc	8/8	19.0	15.8 - 869.5	200	4.34	Retained - HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	1/7	5.71	1,400	100	14	Retained - HQ > 1
4,4'-DDE	3/7	12.38	15.55 - 1,730	100	17.3	Retained - HQ > 1
4,4'-DDT	4/7	7.62	5.38 - 4,700	100	47	Retained - HQ > 1
Aroclor-1260	2/7	32.44	644 - 900	NA		Retained - no suitable threshold was available
Endrin	1/7	ND	19.7	100	0.2	Eliminated - does not exceed threshold
Endrin aldehyde	1/6	ND	45	100	0.45	Eliminated - does not exceed threshold
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetophenone	1/10	ND	120	NA		Retained - no suitable threshold was available
Anthracene	2/10	471	256.75 - 280	100	2.8	Retained - HQ > 1
Benzo(a)anthracene	4/10	ND	160 - 3,420	100	34.2	Retained - HQ > 1

TABLE 4-29
ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 1
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg) (cont.)						
Benzo(a)pyrene	4/10	ND	200 - 2,185	100	21.8	Retained - HQ > 1
Benzo(b)fluoranthene	4/10	471	270 - 6,830	100	68.3	Retained - HQ > 1
Benzo(g,h,i)perylene	4/10	ND	180 - 1,940	100	19.4	Retained - HQ > 1
Benzo(k)fluoranthene	3/10	ND	160 - 410	100	4.1	Retained - HQ > 1
Bis(2-ethylhexyl)phthalate	4/10	471	120 - 2,200	NA		Retained - no suitable threshold was available
Chrysene	5/10	461	210 - 5,435	100	54.3	Retained - HQ > 1
Di-n-butyl phthalate	3/10	427	86 - 230	NA		Retained - no suitable threshold was available
Dibenzo(a,h)anthracene	4/9	ND	84 - 604.5	100	6.04	Retained - HQ > 1
Fluoranthene	5/10	ND	250 - 7,100	100	71	Retained - HQ > 1
Hexachlorophene	3/6	526	670 - 890	NA		Retained - no suitable threshold was available
Indeno(1,2,3-cd)pyrene	4/10	ND	190 - 1,585	100	15.8	Retained - HQ > 1
Phenanthrene	5/10	ND	120 - 2,755	100	27.5	Retained - HQ > 1
Pyrene	5/10	478	320 - 6,290	100	62.9	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
1,1,2,2-tetrachloroethane	1/8	1.96	1	300	0.0033	Eliminated - does not exceed threshold
2-butanone	1/8	ND	32	NA		Retained - no suitable threshold was available
2-hexanone	1/8	3.92	1	NA		Retained - no suitable threshold was available
Acetone	3/8	3.67	49 - 230	NA		Retained - no suitable threshold was available
Acetonitrile	1/5	ND	9	NA		Retained - no suitable threshold was available
Bis(2-chloroisopropyl)ether	1/10	32.10	6	NA		Retained - no suitable threshold was available
Chlorodibromomethane	1/8	ND	0.44	NA		Retained - no suitable threshold was available
Ethylbenzene	3/8	1.65	0.34 - 2	100	0.02	Eliminated - does not exceed threshold
Methylene chloride	2/8	2.80	10 - 70	300	0.23	Eliminated - does not exceed threshold
Toluene	4/8	1.71	2 - 7	100	0.07	Eliminated - does not exceed threshold
Trans-1,4-dichloro-2-butene	1/8	ND	2	1,000	0.002	Eliminated - does not exceed threshold
Xylenes (total)	1/8	ND	7	100	0.07	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-30

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR TERRESTRIAL PLANTS - SWMU 1
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECPC
INORGANICS (mg/kg)						
Aluminum	7/7	2,130	1,540 - 7,810	50	156.2	Retained - HQ > 1
Antimony	4/8	0.43	1.3 - 21.7	5	4.34	Retained - HQ > 1
Arsenic	5/8	1.40	1.2 - 6.4	10	0.64	Eliminated - does not exceed threshold
Barium	8/8	11.0	9.7 - 99.6	500	0.20	Eliminated - does not exceed threshold
Beryllium	3/8	0.05	0.13 - 0.2	10	0.02	Eliminated - does not exceed threshold
Cadmium	6/8	0.17	0.96 - 11.2	3	3.73	Retained - HQ > 1
Chromium	8/8	6.22	7.5 - 184	1	184	Retained - HQ > 1
Cobalt	6/8	0.34	0.45 - 4.6	20	0.23	Eliminated - does not exceed threshold
Copper	8/8	5.28	4.3 - 407	100	4.07	Retained - HQ > 1
Lead	54/58	16.8	0.47 - 740	50	1.48	Retained - HQ > 1
Manganese	7/7	19.4	19.1 - 467	500	0.93	Eliminated - does not exceed threshold
Mercury	6/8	0.03	0.12 - 6.2	0.3	20.7	Retained - HQ > 1
Nickel	7/8	1.63	3.3 - 50.2	30	1.67	Retained - HQ > 1
Selenium	3/8	0.72	0.24 - 0.61	1	0.61	Eliminated - does not exceed 2 X background
Silver	6/8	ND	0.58 - 7.6	2	3.8	Retained - HQ > 1
Tin	4/4	1.94	3.6 - 11.8	50	0.24	Eliminated - does not exceed threshold
Vanadium	8/8	3.71	3.35 - 11.1	2	5.6	Retained - HQ > 1
Zinc	8/8	19.0	15.8 - 869.5	50	17.4	Retained - HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	1/7	5.71	1,400	NA		Retained - no suitable threshold was available
4,4'-DDE	3/7	12.38	15.55 - 1,730	NA		Retained - no suitable threshold was available
4,4'-DDT	4/7	7.62	5.38 - 4,700	NA		Retained - no suitable threshold was available
Aroclor-1260	2/7	32.44	644 - 900	4.00E+04	0.00	Eliminated - does not exceed threshold
Endrin	1/7	ND	19.7	NA		Retained - no suitable threshold was available
Endrin aldehyde	1/6	ND	45	NA		Retained - no suitable threshold was available
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetophenone	1/10	ND	120	NA		Retained - no suitable threshold was available
Anthracene	2/10	471	256.75 - 280	NA		Retained - no suitable threshold was available
Benzo(a)anthracene	4/10	ND	160 - 3,420	NA		Retained - no suitable threshold was available
Benzo(a)pyrene	4/10	ND	200 - 2,185	NA		Retained - no suitable threshold was available

TABLE 4-30

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR TERRESTRIAL PLANTS - SWMU 1
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECPC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg) (cont.)						
Benzo(b)fluoranthene	4/10	471	270 - 6,830	NA		Retained - no suitable threshold was available
Benzo(g,h,i)perylene	4/10	ND	180 - 1,940	NA		Retained - no suitable threshold was available
Benzo(k)fluoranthene	3/10	ND	160 - 410	NA		Retained - no suitable threshold was available
Bis(2-ethylhexyl)phthalate	4/10	471	120 - 2200	NA		Retained - no suitable threshold was available
Chrysene	5/10	461	210 - 5,435	NA		Retained - no suitable threshold was available
Di-n-butyl phthalate	3/10	427	86 - 230	2.00E+05	0.00	Eliminated - does not exceed threshold
Dibenzo(a,h)anthracene	4/9	ND	84 - 604.5	NA		Retained - no suitable threshold was available
Fluoranthene	5/10	ND	250 - 7,100	NA		Retained - no suitable threshold was available
Hexachlorophene	3/6	526	670 - 890	NA		Retained - no suitable threshold was available
Indeno(1,2,3-cd)pyrene	4/10	ND	190 - 1,585	NA		Retained - no suitable threshold was available
Phenanthrene	5/10	ND	120 - 2,755	NA		Retained - no suitable threshold was available
Pyrene	5/10	478	320 - 6,290	NA		Retained - no suitable threshold was available
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
1,1,2,2-tetrachloroethane	1/8	1.96	1	NA		Retained - no suitable threshold was available
2-butanone	1/8	ND	32	NA		Retained - no suitable threshold was available
2-hexanone	1/8	3.92	1	NA		Retained - no suitable threshold was available
Acetone	3/8	3.67	49 - 230	NA		Retained - no suitable threshold was available
Acetonitrile	1/5	ND	9	NA		Retained - no suitable threshold was available
Bis(2-chloroisopropyl)ether	1/10	32.10	6	NA		Retained - no suitable threshold was available
Chlorodibromomethane	1/8	ND	0.44	NA		Retained - no suitable threshold was available
Ethylbenzene	3/8	1.65	0.34 - 2	NA		Retained - no suitable threshold was available
Methylene chloride	2/8	2.80	10 - 70	NA		Retained - no suitable threshold was available
Toluene	4/8	1.71	2 - 7	2.00E+05	0.00	Eliminated - does not exceed threshold
Trans-1,4-dichloro-2-butene	1/8	ND	2	NA		Retained - no suitable threshold was available
Xylenes (total)	1/8	ND	7	1.00E+05	0.00	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

4.1.8.4.1.3 Food Chain Modeling for the Lower Keys Marsh Rabbit

For the maximum soil contaminant concentration exposure scenario, the total hazard index for the Lower Keys marsh rabbit was 187 (Table 4-31). Of this total, antimony (47.6 percent), barium (13.4 percent), chromium (9.4 percent), cadmium (8.6 percent), and silver (6.2 percent) contributed the most to total potential risk. The remaining ECPCs comprised 15.0 percent of the total. Incidental ingestion of contaminated soil accounted for 59.3 percent of the total dose, while ingestion of contaminated forage comprised 40.7 percent. The ingestion of contaminated drinking water and dermal exposure was negligible.

For the mean soil contaminant concentration scenario, the total hazard index was 48.4 (Table 4-32). Antimony (36.0 percent), barium (15.1 percent), cadmium (8.9 percent), silver (7.9 percent), and aluminum (6.6 percent) contributed the most to total potential risk, with all other ECPCs accounting for 20.0 percent of the total. Incidental ingestion of contaminated soil accounted for 55.8 percent of total dose, and ingestion of contaminated forage constituted 44.2 percent of total dose.

4.1.8.4.1.4 Toxicity Testing

Survival and growth of the mysid shrimp in sediment from SWMU 1 were similar to values in laboratory controls (Table 4-33). Fertilization and development of mussel larvae from this site were similar to control values. Sea urchin fertilization was slightly reduced (although not significantly lower than laboratory controls) in two of five samples. Survival of silverside minnows from this site was slightly (but not significantly) lower than in laboratory controls. Earthworm survival in both soil samples from this site was significantly lower than control values.

4.1.8.4.1.5 Tissue Analysis

Crested gobies, fat sleepers, sailfin mollies, and sheepshead minnows were collected from small ponded areas within the mangrove swamp at SWMU 1, and were composited by species into samples of approximately 30 grams each. Analytes detected in fish consisted of arsenic, barium, copper, lead, selenium, zinc, aldrin, delta-BHC, Aroclor-1260, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT (Table 4-24).

Several metals were detected in earthworms after 28 days of exposure to site soils (Table 4-34).

TABLE 4-31

MAJOR CONTRIBUTORS TO RISK FOR THE LOWER KEYS MARSH RABBIT MAXIMUM SOIL CONTAMINANT CONCENTRATION SCENARIO - SWMU 1 NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPC)	Total Hazard Index (HI) per ECPC for all Pathways	% Contribution of ECPC to Total Receptor HI
Antimony	88.9	47.6
Barium	25.1	13.4
Chromium	17.6	9.4
Cadmium	16.1	8.6
Silver	11.5	6.2
All others	27.5	15.0
Total receptor HI	187	

Pathway	Total HI per Pathway	% Contribution of Pathway to Total Receptor HI
Soil	111.2	59.3
Water	0.0	0.0
Food	76.3	40.7

TABLE 4-32

MAJOR CONTRIBUTORS TO RISK FOR LOWER KEYS MARSH RABBIT MEAN SOIL CONTAMINANT CONCENTRATION SCENARIO - SWMU 1 NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPC)	Total Hazard Index (HI) per ECPC for all Pathways	% Contribution of ECPC to Total Receptor HI
Antimony	18.4	36.0
Barium	7.7	15.1
Cadmium	4.6	8.9
Silver	4.1	7.9
Aluminum	3.4	6.6
All others	10.2	20.0
Total Receptor HI	48.4	

Pathway	Total HI per Pathway	% Contribution of Pathway to Total Receptor HI
Soil	27.0	55.8
Water	0.0	0.0
Food	21.4	44.2

TABLE 4-33

TOXICITY TEST RESULTS - SWMU 1
NAS KEY WEST

Test Type and Endpoint	Sample						
	Control	**1**	**2**	**3**	**4**	**5**	**7**
Earthworm 14-day soil toxicity test (% survival)	85	NT	NT	NT	NT	0*	42*
Sea urchin fertilization test (% eggs fertilized)	99.7/84.1(1)	99.0	99.4	61.4	92.5	78.7	NT
Mussel 48-hour larval development (% normal)	96.5/92.4(2)	96.2	94.4	93.5	94.2	93.0	NT
Silverside minnow 96-hour acute toxicity test (% survival)	100	80	75	NA	90	75	NT
Mysid shrimp 10-day sediment toxicity test (% survival and total growth in mg)	86.7(3)	91.7	93.3	85.0	88.3	88.3	NT
	0.252(4)	0.327	0.279	0.327	0.251	0.220	NT

NA = Not available from testing laboratory.
NT = Not applicable.
*Result significantly different from control.

1 Fertilization success was 99.7% in laboratory controls tested concurrently with samples 1 and 2; survival was 84.1% in laboratory controls tested concurrently with samples 3, 4, and 5.
2 Normal larval development was 96.5% in laboratory controls tested concurrently with samples 1 and 2; survival was 92.4% in laboratory controls tested concurrently with samples 3, 4, and 5.
3 % survival.
4 Total growth in milligrams (mg).

TABLE 4-34

METAL CONCENTRATIONS IN EARTHWORM TISSUE (MG/KG WET WEIGHT) SWMU 1 AND BACKGROUND SITES NAS KEY WEST

Metal	SWMU 1		Background		
	S1SS-05	S1SS-07	BG1	BG2	S1SS-04
Antimony	10.6	<4.9	<4.9	<5.0	<4.8
Arsenic	2.9	1.9	0.79	0.79	0.97
Barium	54.8	14.2	7.6	1.7	5.0
Beryllium	<0.38	<0.40	<0.39	<0.40	<3.8
Cadmium	4.1	2.0	<0.49	<0.50	<0.48
Chromium	38.1	8.4	4.0	<1.0	2.5
Cobalt	2.2	<0.99	<0.98	<1.0	<0.95
Copper	296	59.3	4.2	2.6	2.3
Lead	319	92.2	4.2	0.45	3.9
Mercury	2.7	0.18	<0.02	<0.02	<0.02
Nickel	26.9	3.8	<1.5	<1.5	<1.4
Selenium	<0.24	1.3	<1.2	0.28	0.30
Silver	1.7	<0.49	<0.49	<0.50	<0.48
Thallium	<0.19	<0.20	<0.20	<0.20	<0.19
Tin	34.2	<4.9	<4.9	<5.0	<4.8
Vanadium	4.5	2.8	2.6	<1.0	1.8
Zinc	397	324	21.3	13.5	15.7

4.1.8.4.2 Discussion

Several inorganic and organic contaminants were identified as ECCs in groundwater, but most hazard quotients indicated low potential risk in comparison to surface water screening values. Hazard quotients were high for aluminum, cyanide, lead, and mercury, and these contaminants were detected in approximately one third to one half of groundwater samples. Barium had an elevated HQ and was detected in all samples in which it was analyzed for. Aldrin in groundwater also had a high hazard quotient, but this pesticide was detected in only 1 of 24 samples. Bis(2-ethylhexyl)phthalate had an elevated HQ value but was detected in only 3 of 17 samples and phthalates are ubiquitous in the environment. Although groundwater is not directly available to ecological receptors, it could become available to such receptors by discharging to surface water or sediment. At SWMU 1, several contaminants identified as ECCs in groundwater were also identified as ECCs in surface water and sediment. However, although groundwater contaminants that discharge to surface water can have an additive effect with surface-water contaminants from other sources, they probably will be diluted upon discharge to surface water.

Seven metals and one organic compound (carbon disulfide) were identified as ECCs in surface water. Of these contaminants, copper, lead, and mercury had hazard quotients indicative of moderately high to high risk. Nonetheless, each of these three metals was detected in only half of the surface-water samples or less.

A total of 29 metals and organic compounds exceeded their respective benchmark values in sediment and were retained as ECCs, while 13 contaminants were conservatively retained as ECCs because no suitable sediment benchmarks were available. Although most of the hazard quotients were indicative of low risk, the large number of contaminants is noteworthy. While individual sediment contaminants can appear to pose low risks, the large number of sediment contaminants at SWMU 1 could result in additive toxic effects that could, in turn, result in significant potential risks to ecological receptors. In addition, copper, lead, and mercury, which accounted for most of the potential risk in surface water, all exceeded less conservative benchmarks in sediment, indicating ubiquitous contamination in the aquatic system.

Several metals and organic compounds were identified as ECCs in SWMU 1 soils. Hazard quotients were indicative of moderately high potential risk for aluminum, mercury, tin, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, ideno-(1,2,3-cd)pyrene, phenanthrene, and pyrene, while the hazard quotient for chromium suggests the potential for extreme potential risk. Most of these ECCs were detected in a large proportion of samples and at concentrations where even the lowest detected values exceeded their respective benchmarks.

Thus, based on the soil screening assessment, it appears that soil contamination at SWMU 1 might pose significant potential risks to ecological receptors despite recent soil remediation.

The scarcity of terrestrial plant benchmarks for organic compounds precluded a detailed assessment of potential risks to terrestrial plants from organics in surface soil. However, plants do not translocate organics to the extent that they translocate inorganics. For metals, hazard quotients were relatively high for aluminum, chromium, lead, mercury, and zinc. Frequencies of detection were high for these contaminants.

Results of the food-chain modeling indicate a rather high hazard index of 187 under the maximum soil contaminant concentration exposure scenario; the HI was 48.4 under the mean soil contaminant concentration scenario. The mean contaminant concentration scenario is probably more appropriate for estimating risk than the maximum contaminant concentration scenario because the rabbit (and other terrestrial receptors) use resources over relatively large areas, and the maximum concentrations might indicate only "hot spots" of contamination. Under both scenarios, antimony and barium contributed the most to total potential risk. In addition, incidental ingestion of contaminated soil and ingestion of contaminated forage each comprised approximately half of the total dosage. The potential risk due to antimony is probably not as great as indicated by the food-chain modeling. Toxicity data were limited for this metal. As a result, several uncertainty factors were needed to calculate an RfD for antimony. Therefore, the high HI value might be due largely to the uncertainty in toxic effects rather than to potential risk. Further uncertainty in the food-chain model results from the conservative assumption that the marsh rabbit spends all its time foraging on the site. Most of the soil in the former burn and disposal areas that comprise SWMU 1 has been excavated, leaving a small portion of potentially contaminated soil only a fraction of a hectare in size. The average home range of the marsh rabbit is 1.2 hectares. Therefore, it is unlikely that a marsh rabbit would spend a significant amount of time foraging on the residually contaminated area or on the site as a whole, especially because large portions of the site are frequently inundated with water.

The surface-water and sediment toxicity tests did not show the degree of toxic effects that might be expected based on the results of the screening assessments and the elevated levels of several contaminants in aquatic media at SWMU 1. Sediment toxicity test results were similar to those in laboratory controls, as were the mussel larval tests conducted in surface water from the site. Sea urchin fertilization was similar to control values in three of the five samples from this site, but lower than control values (although not significantly) in the other two samples. Survival of silverside minnows from this site was slightly (but not significantly) lower than laboratory controls. However, the salinity of sample Nos. 4 and 5 was 34 ppt, slightly higher than the 32 ppt maximum value recommended in toxicity tests using the silverside minnow. This may have been a confounding factor in the reduced survival of sample No. 5, but survival in sample No. 4 was normal (90 percent). Salinity in the other SWMU 1 samples was 27-29 ppt, and thus, within recommended limits. A conservative conclusion is that the reduced sea urchin fertilization in Sample No. 3 and silverside minnow survival in Sample Nos. 2 and 5 were due to site-related toxicity. However, the absence of toxic effects in most tests suggests that site-related contaminants in surface water and sediment are not acutely toxic. Results for reproductive and developmental endpoints also suggest the lack of chronic effects from site contaminants. Furthermore, the contaminants in surface water and sediment might not be in bioavailable form. Surface-water contaminants might not be in the more toxic dissolved form. Site sediments might contain high levels of TOC and acid volatile sulfide (AVS). TOC and AVS in sediments bind organic and inorganic contaminants, respectively, reducing their toxicity to aquatic organisms.

Results of the soil toxicity tests suggest significant potential risk to soil invertebrates. Earthworm survival in soils from this site was significantly reduced in both samples. Worms in Sample No. 5 exhibited considerable stress when placed in the test chambers; they actively attempted to avoid the soil by climbing up the sides of the chambers. Many worms in this sample were dead within 24 hours after test initiation, and none survived the 14-day test. Concentrations of metals in earthworms from both site samples were generally higher than those in earthworms exposed to three background sites, suggesting potential risks to terrestrial invertebrates from soil contaminants, primarily metals.

Concentrations of pesticides in fish collected from SWMU 1 were higher than those in fish collected from background locations, but were generally less than concentrations considered to be hazardous to piscivorous receptors. Concentrations of arsenic, copper, and selenium in fish from SWMU 1 were similar to those in fish from background sites. Barium and lead concentrations in sailfin mollies and sheepshead minnows from SWMU 1 were higher than those in background fish. Lead in most samples of those two species at SWMU 1 exceeded the 2.0 mg/kg concentration considered to be hazardous to piscivorous receptors. No protective thresholds for piscivorous receptors were available for barium. As discussed above, elevated concentrations of mercury, copper, and lead were detected in some surface-water samples. Mercury, however, was not detected in fish from SWMU 1, and copper was detected only at concentrations similar to those in background samples. Overall, with the exception of lead, the fish tissue concentrations were not indicative of potential risks to piscivorous receptors, nor do they suggest bioaccumulation or bioconcentration of contaminants at SWMU 1.

4.1.8.5 Ecological Risk Summary

The Phase I ecological screening assessment concluded that the incidental ingestion of soil posed high potential risk from several COCs to terrestrial receptors, and contaminated forage appeared to present moderate potential risks. Furthermore, piscivores appeared to be at risk from all types of COCs that bioaccumulate in food items, and fish were at greatest risk from inorganics in surface water (IT Corporation, 1994). After the Phase I assessment, soil on most of the site was excavated to bedrock and replaced with clean fill material.

In this Phase II assessment, a number of metals and organic compounds were detected in groundwater, surface-water, sediment, and soil samples collected from locations outside the excavated area. Concentrations of several contaminants exceeded benchmark values (especially in soil), suggesting potential risks to ecological receptors. However, the potential risks suggested by the current screening assessment are mitigated by several factors, which are summarized below.

Toxicity tests using SWMU 1 sediment and surface water indicated low potential risks to aquatic receptors. For the most part, results of the toxicity tests were similar to results from controls. In addition, tissue concentrations of contaminants in fish collected from the mangrove swamp in the eastern portion of the site were relatively low, indicating low potential risks to aquatic receptors. Lead appears to be accumulating to some degree in the tissues of a few fishes, but most of the contaminated area was excavated, mainly due to lead detected in site soils during Phase I and interim remedial action (IRA) sampling activity. Therefore, although contaminant concentrations in surface water and sediment were relatively high, toxicity tests and tissue analyses suggest the absence of significant contaminant bioavailability to aquatic receptors and piscivorous terrestrial receptors.

Estimated potential risks to the Lower Keys marsh rabbit, the representative terrestrial receptor, were moderate, but were heavily mitigated by the conservative assumptions used in the food-chain model. To begin with, antimony, which accounted for the majority of potential risks, was detected in only half of the soil samples. More important, the high risk numbers for this inorganic are probably due to the lack of toxicity data and subsequent use of several of the uncertainty factors used in RfD development. This investigation also assumed that the marsh rabbit forages on the site 100 percent of the time, but this is probably not the case because much of the site is frequently inundated with water, and therefore does not offer significant terrestrial habitat. No signs of the marsh rabbit have been found on SWMU 1. Better terrestrial habitats are located on the west side of Stone Road, which is not part of SWMU 1 or known to be contaminated.

Surface soils contain elevated concentrations of several contaminants and might be toxic to soil invertebrates, as indicated by significant mortality to earthworms in toxicity tests. Nonetheless, as mentioned above, much of the habitat on and near SWMU 1 is aquatic and vegetation is sparse. Therefore, its use by terrestrial receptors is likely to be minimal, and the rocky nature of the soils precludes use by many types of invertebrates.

In summary, the Phase I and the Phase II ecological risk assessments appear to be sufficient to characterize potential ecological risks at SWMU 1. Some metals in surface water and groundwater and some metals, pesticides, and PAHs in sediment and surface soil significantly exceed ecological benchmarks. A number of factors mitigate most of the related risks, although some significant risks appear to be associated with several contaminants in site soils and lead in surface water and sediments. However, despite the elevated levels of some soil contaminants in the area of residual post-excavation contamination (the remaining source), this portion of the site appears to be small in relation to residual potential risks. Specifically, most of the elevated concentrations of soil contaminants were detected north of the gravel road at the north end of the site. This area is relatively small, little soil is present, and the road separates the area from the mangrove swamp. Therefore, additional ecological studies or remediation do not appear to be necessary, but biomonitoring of SWMU 1 ecological receptors might be useful to ensure that contaminant levels in site-related receptors decrease temporally and that the removal action at the site was effective.

4.1.9 Conclusions and Recommendations

As mentioned above, SWMU 1 was the subject of a substantial interim removal of soil and sediment that occurred in the Spring of 1996. This remedial action removed approximately 6,275 cubic yards of soil and sediment from the site. Still at the site, however, is soil and sediment contamination in some areas of the mangrove swamp east of the excavated area. These areas contain low to moderate concentrations of metals, pesticides, and SVOCs including PAHs. This contamination by metals and SVOCs is not limited to a specific contiguous region of the site, although most observations of the maximum soil and sediment semivolatile concentrations occurred in the northeast and north-central regions of the site. Surface water at the site also contains the same metals and semivolatile compounds. Beryllium, cadmium, copper, lead, manganese, mercury, vanadium, and zinc all exist above stream and surface-water limits, but their occurrence usually seems to be isolated. Groundwater at the site is predominantly contaminated with metals and SVOCs. Although aluminum and, most significantly, lead and antimony were detected above drinking water limits in groundwater in past studies, none of these metals was detected in the most recent groundwater analyses. In summary, soil and sediment at the site contain levels of metals and SVOCs above screening levels. In addition, groundwater at the site in the past has contained levels above drinking water MCLs and might still contain these contaminants, although none of the 1996 samples of a few groundwater wells detected these contaminants at the boundary areas selected for supplemental sampling.

The human health risk posed by the site for the future residential exposure scenario are above acceptable thresholds of 1E-04 for cancer risk and 1.0 for noncancer risk. Because the location of SWMU 1 is within the flight control area of NAS Key West, base personnel have stated that, as long as the runways are in active use for military or even commercial use, government restrictions would prevent residential use of SWMU 1. Therefore, the likely foreseeable future use of SWMU 1 would be other than the residential use scenario. The human health risk posed under other scenarios studied in this section are all within the EPA target risk range of 1E-04 to 1E-06; this is a borderline risk that could necessitate corrective action.

The Phase I ecological screening assessment that IT Corporation conducted before the interim removal activities at SWMU 1 concluded that there was moderate ecological risk at the site based on ingestion of soil by terrestrial receptors and bioaccummulation through food items by piscivores. The Phase II assessment conducted as part of this Supplemental RFI/RI also concluded that there are potential risks to ecological receptors; however, these are borderline ecological risks that several factors can mitigate. Lead appears to be accumulating to some degree in the tissues of a few fish, but most of the lead-contaminated areas of soil and sediment have been excavated. Although contaminant concentrations in surface water and sediment were relatively high, the interim remediation suggests the absence of significant future contaminant bioavailability to aquatic receptors and piscivore or terrestrial receptors. In addition, most of the elevated concentrations of soil contaminants that remain were detected north of the gravel road at the northern portion of the site; this is a relatively small area separated from the mangrove swamp by the road. Therefore, additional ecological studies or remediation do not appear to be solely justified based on ecological risk. Future biomonitoring of SWMU 1 ecological receptors might prove useful, however, to ensure that the contaminant levels in site-related receptors decrease temporally and that the removal action at the site was sufficient to mitigate this borderline ecological risk.

This Supplemental RFI/RI, therefore, recommends the performance of a corrective measures study for SWMU 1 to consider the borderline human health risk and borderline ecological risks posed as described above. While the need for additional corrective action at SWMU 1 is unclear, and the degree of the interim removal activities might be sufficient to mitigate human and ecological risk, the potential need for limited additional remediation and additional groundwater and biological receptor monitoring should be part of the corrective measures study evaluation.

4.2 SWMU 2, BOCA CHICA DDT MIXING AREA

This section presents the site-specific evaluation of data for SWMU 2. It discusses the site's previous investigations, RFI/RI rationale, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, baseline human health risk assessment, and ecological risk assessment. Conclusions and recommendations for SWMU 2 are presented in Section 4.2.9.

4.2.1 Unit Description

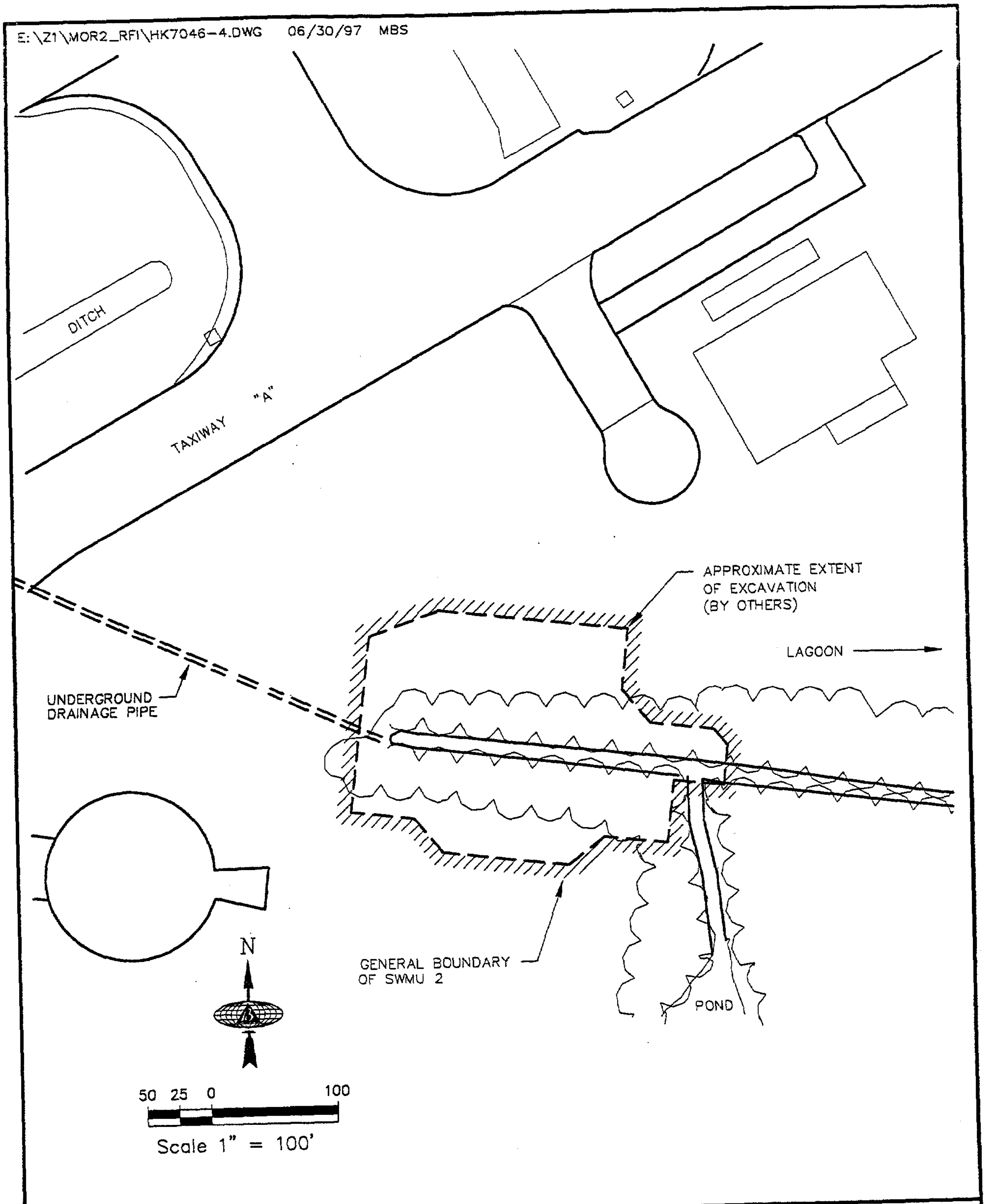
SWMU 2 (previously identified as Site No. 5) is the former location of Building 915 and its surrounding area, which was used for the storage and mixing of pesticides (Figure 4-12). Two aboveground tanks on concrete foundations (a 500-gallon mixing tank and a 1,000-gallon storage tank) were located to the west of the building. 4,4'-DDT mixing operations were conducted at this location from the mid-1940s to the early 1970s. Building 915 was demolished in 1982, and the site is a vacant, sparsely vegetated lot covering approximately 0.25 acre. It is on the northern edge of a manmade ditch that exits into a lagoon that has formed in a borrow pit. The ditch receives surface water runoff from the vicinity of SWMU 2 and from the area north of the site. The lagoon and ditch are inhabited by fish and wading birds and support mangroves and other plant life.

4.2.2 Site-Specific Investigations

This section summarizes the results from the investigations that have been conducted at SWMU 2 through the Spring of 1996. Previous investigations include all the studies conducted before the Supplemental RFI/RI in January 1996. Current investigations include the Supplemental RFI/RI conducted by B&R Environmental and confirmational sampling conducted by BEI after the IRA conducted during the Spring of 1996.

4.2.2.1 Previous Investigations

Section 1.3 summarizes previous investigations conducted at NAS Key West. This section provides more details about those investigations at SWMU 2.



SITE MANAGER: RD	CHECKED BY: KW	Brown & Root Environmental	FIGURE 4-12 **SITE LOCATION MAP SWMU 2** NAVAL AIR STATION BOCA CHICA KEY, FLORIDA
DRAWN BY: TCB	DRAWING DATE: 7/24/96		
SURVEYED BY: TCB	SURVEY DATE: 2/21/96		
SCALE: 1" = 100'			
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046		

4.2.2.1.1 Initial Investigation

During a study conducted by Geraghty & Miller in 1986, the site was divided into six plots, and three sample points were selected in each plot. Soil samples were collected at one-foot intervals to a depth of three feet at each sampling point. The exact locations of these points are unknown. The laboratory analyses of the soil samples indicated the presence of pesticides throughout the three-foot sampling range. The highest concentrations ranged from 80 to 936 ppm of 4,4'-DDT and its degradation products 4,4'-DDE and 4,4'-DDD. In addition, other pesticide-related compounds were detected including alpha-BHC, beta-BHC, gamma-BHC (lindane), and delta-BHC.

4.2.2.1.2 Preliminary Remedial Investigation

During the Preliminary RI in 1990, IT Corporation installed three monitoring wells (MW5-1 through MW5-3) and collected and analyzed samples from all media. This sampling and analysis indicated that the site had high (greater than 1,000 ppm) concentrations of pesticides in each medium. The pesticides 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and related chlorinated hydrocarbon pesticides were detected in soil, sediment, surface-water, and groundwater samples. The soil samples at the site contained the highest pesticide concentration levels. The Preliminary RI concluded that, due to probable leaching in the area, the pesticides are in the sediment and groundwater at this site. The pesticide contamination probably was spread by surface-water runoff, soil erosion, and groundwater movement. Volatile substances such as benzene, 1,2-DCE, chlorobenzene, and naphthalene were also detected.

4.2.2.1.3 RCRA Facility Investigation/Remedial Investigation

The RFI conducted by IT Corporation in 1993 included the installation of three monitoring wells (S2MW-1 through S2MW-3) and the analysis of samples from all media. The investigation found that the COCs (obtained by comparing concentrations of compounds detected in groundwater above background concentrations with action levels) were primarily VOCs and pesticides. For soil, the RFI found that the COCs were primarily pesticides. Sediments at the site were also found to be impacted by pesticides. The sediment contamination appeared to be the result of soil erosion due to surface-water runoff from the site. The RFI report concluded that there are no current or future human health risks above a level of concern. Because contaminated sediment continues to migrate from the site into surface-water drainage ditches and ultimately into a lagoon, several contaminants have the potential for bioaccumulation and could result in unacceptable current or future ecological risks.

4.2.2.1.4 Delineation Sampling

In 1995, BEI performed delineation sampling on a 25-by-25-foot grid at SWMU 2. Pesticides were detected above soil screening criteria at several locations around the former 4,4'-DDT mixing building and south of the ditch. Lead was not detected above screening criteria in samples collected along the banks of the ditch. Samples collected from the sediment in the ditch exceeded screening levels for pesticides, but not for lead.

4.2.2.2 Current Investigations

The scope of Supplemental RFI/RI at SWMU 2 is summarized in Section 4.2.3.1. In addition to the results from the Supplemental RFI/RI, additional data were obtained from the confirmational sampling conducted by BEI in April 1996, after the interim remedial action. These data were accepted and used in the analyses for SWMU 2 to provide a comprehensive analysis of data for making decisions about SWMU 2. Data from the confirmational sampling were not validated, which adds some conservatism to the analyses.

4.2.3 RCRA Facility Investigation Rationale

This section presents the reasons for conducting the Supplemental RFI/RI activities at SWMU 2. Section 4.2.3.1 discusses the scope of the field work performed in January 1996; Section 4.2.3.2 discusses analytical parameters.

4.2.3.1 Scope of the Field Investigation

The primary objectives of supplemental sampling activities at SWMU 2 were to characterize background soil characteristics in the immediate area surrounding the site, determine the extent to which pesticides have migrated in the canal system that adjoins the site, and delineate the area of groundwater contamination with respect to contaminants that were detected in previous work.

Previous surface soil data indicated that the area of pesticide residue has not been defined. Therefore, the scope of IRA sampling activities by BEI included soil sampling in outlying areas to assess the areal extent of pesticides contamination. The soil sampling data from BEI were considered to be adequate for satisfying RFI/RI program objectives. Preliminary soil and sediment data from the BEI delineation sampling indicate anthropogenic low-level concentrations of pesticides in the surrounding soil and sediment. Therefore, toxicological testing of sediment and surface water at SWMU 2 was conducted during this phase of the Supplemental RFI/RI to support the ecological risk assessment.

The distribution of pesticides in groundwater at the site was not completely delineated in previous work. The scope of work at this site includes installing and sampling four additional monitoring wells (S2MW-4 through S2MW-7) to supplement existing data.

4.2.3.2 Analytical Parameters

Groundwater samples at SWMU 2 were analyzed for the following parameters:

- Appendix IX pesticides and PCBs
- Herbicides
- TAL metals
- Cyanide

4.2.4 Site Geology and Hydrogeology

The regional geology and hydrogeology of the Florida Keys are described in Sections 3.4 and 3.5 of this report. The site-specific geology and hydrogeology of the unit were determined from soil borings and monitoring wells installed during the Preliminary RI, the RFI/FI, and the Supplemental RFI/RI.

4.2.4.1 Geology and Soils

The subsurface lithology at the site was characterized from descriptions of split-spoon samples collected during installation of the borings. Samples collected from borings S2MW-5 and S2MW-6 directly adjacent to the manmade drainage ditch revealed the presence of fill material from the surface to approximately four feet bls. Specifically, the fill material was composed of loosely consolidated sand and gravel, crushed limestone, and minor amounts of clay. The indigenous oolitic limestone was encountered below the fill and at the surface in borings S2MW-4 and S2MW-7. The limestone continued in each boring until termination at approximately 13 feet bls. The SPT, blow count as defined by ASTM D156, indicated that the limestone is of medium density.

Geotechnical data (obtained from a composite surface soil sample during the Preliminary RI) included grain size distribution, moisture content, soil pH, cation exchange capacity, TOC content, and permeability. The grain size analysis indicated that the soil sample is a silty, medium- to fine-grained sand with 12 percent passing a 200-mesh sieve. The pH of the sample was 8.25, slightly alkaline due to the abundance of carbonate rock. The ion exchange capacity of the soil (the ability to capture and retain cations) was 35.74 meq/g and is representative of a low value. The TOC value of 1.04 mg/kg indicates little organic matter and the medium's inability to attenuate organic contaminants. The permeability of the soil was 2.29E-06 cm/sec, which is representative of a low-permeability material (IT Corporation, 1994).

4.2.4.2 Hydrogeology

Four wells were installed during the Supplemental RFI/RI. Monitoring well construction logs are included in Appendix K. Based on the construction logs and groundwater level measurements, the depth to groundwater was between 1.5 and 2.5 feet bls. Data from the logs also indicate that oolitic limestone was encountered to the maximum depth of 13 feet penetrated on the site. The hydrogeologic unit associated with the oolitic limestone is the surficial aquifer. Due to the highly permeable nature of the oolitic limestone, the surficial aquifer is likely to have hydraulic conductivity values at the high-end range of 72 gpd/ft^2 to 1,024 gpd/ft^2.

Groundwater flow direction during the RFI/RI was determined to be southerly, toward the ditch and the lagoon, with a hydraulic gradient of 0.0017 ft/ft. Groundwater level measurements collected during a five-week period from April 14, 1993, to May 10, 1993, were consistent. Groundwater level measurements collected on January 28, 1996, indicate westerly flow with groundwater elevations at approximately 1 foot below mean sea level. Seasonal variations appear to affect groundwater levels (IT Corporation, 1994) at the site. Figure 4-13 shows groundwater flow directions observed at SWMU 2.

4.2.5 <u>Nature and Extent of Contamination</u>

The nature and extent of contamination were investigated by analyzing samples from soil, sediment, surface water, and groundwater in the vicinity of the 4,4'-DDT Mixing Area. The results of these analyses were compared with the ARAR or SAL that was most restrictive for a given chemical in the given medium, shown in Section 2.3.1. The discussion in this section focuses primarily on chemicals that exceeded the most conservative ARAR/SAL criteria and is accompanied by figures which show the concentrations of certain contaminants of interest (COIs). The COIs were selected based on the criteria presented in Appendix G, Section 3.1.3.2. Appendix L contains the analytical data base for all samples.

4.2.5.1 Soil

Chemicals detected in subsurface and surface soils are listed in Tables 4-35 and 4-36, respectively. These tables include analytical results from historical sampling events and current investigations. The

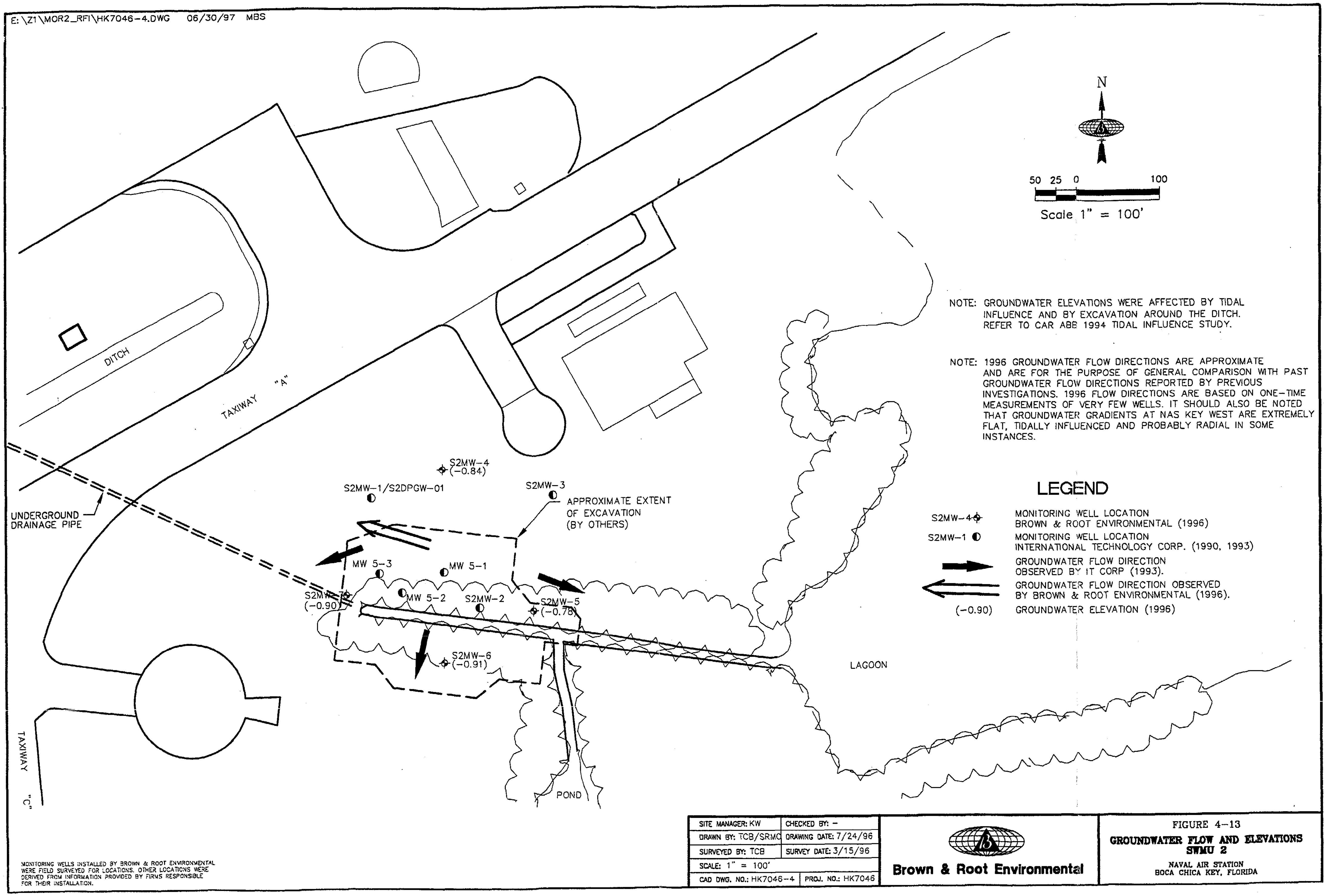

E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS
N
50 25 0 100
Scale 1" = 100'
NOTE: GROUNDWATER ELEVATIONS WERE AFFECTED BY TIDAL INFLUENCE AND BY EXCAVATION AROUND THE DITCH. REFER TO CAR ABB 1994 TIDAL INFLUENCE STUDY.
NOTE: 1996 GROUNDWATER FLOW DIRECTIONS ARE APPROXIMATE AND ARE FOR THE PURPOSE OF GENERAL COMPARISON WITH PAST GROUNDWATER FLOW DIRECTIONS REPORTED BY PREVIOUS INVESTIGATIONS. 1996 FLOW DIRECTIONS ARE BASED ON ONE-TIME MEASUREMENTS OF VERY FEW WELLS. IT SHOULD ALSO BE NOTED THAT GROUNDWATER GRADIENTS AT NAS KEY WEST ARE EXTREMELY FLAT, TIDALLY INFLUENCED AND PROBABLY RADIAL IN SOME INSTANCES.
LEGEND
S2MW-4 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S2MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)
GROUNDWATER FLOW DIRECTION OBSERVED BY IT CORP (1993).
GROUNDWATER FLOW DIRECTION OBSERVED BY BROWN & ROOT ENVIRONMENTAL (1996).
(-0.90) GROUNDWATER ELEVATION (1996)
DITCH
TAXIWAY "A"
TAXIWAY "C"
UNDERGROUND DRAINAGE PIPE
S2MW-4 (-0.84)
S2MW-1/S2DPGW-01
S2MW-3
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
MW 5-3
MW 5-1
MW 5-2
S2MW-2
S2MW-5 (-0.78)
S2MW (-0.90)
S2MW-6 (-0.91)
LAGOON
POND
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-4
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-13
GROUNDWATER FLOW AND ELEVATIONS SWMU 2
NAVAL AIR STATION BOCA CHICA KEY, FLORIDA

TABLE 4-35

CONTAMINANTS DETECTED IN SUBSURFACE SOIL - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S2SB-3	05/93	Arsenic	0.22	B
S2SB-2	05/93	Barium	5.4	BJ
S2SB-3	05/93	Barium	4.6	B
S2SB-4	05/93	Barium	3.5	B
S2SB-3	05/93	Beryllium	0.15	B
S2SB-2	05/93	Beryllium	0.14	BJ
S2SB-2	05/93	Chromium	3.3	
S2SB-3	05/93	Chromium	2.8	
S2SB-4	05/93	Chromium	2.8	
S2SB-4	05/93	Cyanide	25	
S2SB-2	05/93	Cyanide	21	J
S2SB-3	05/93	Lead	3.6	
S2SB-4	05/93	Lead	0.56	
S2SB-2	05/93	Sulfide	300	
S2SB-4	05/93	Tin	4.3	B
S2SB-2	05/93	Zinc	2.1	B
S2SB-4	05/93	Zinc	2	B
S2SB-3	05/93	Zinc	1.5	B
PESTICIDES/PCBs (µg/kg)				
S2SB-3	05/93	4,4'-DDD	32	C
S2SB-4	05/93	4,4'-DDD	30	DJ
S2SB-4	05/93	4,4'-DDD	29	
S2SB-2	05/93	4,4'-DDE	87	XF
S2SB-3	05/93	4,4'-DDE	71	C
S2SB-8	05/93	4,4'-DDE	71	C
S2SB-4	05/93	4,4'-DDE	70	DJ
S2SB-2	05/93	4,4'-DDE	69	DJ
S2SB-4	05/93	4,4'-DDE	63	XF
S2SB-1	05/93	4,4'-DDE	11	C
S2SB-3	05/93	4,4'-DDT	410	C
S2SB-2	05/93	4,4'-DDT	310	XF
S2SB-2	05/93	4,4'-DDT	290	D
S2SB-4	05/93	4,4'-DDT	92	XF
S2SB-4	05/93	4,4'-DDT	90	DJ
S2SB-8	05/93	4,4'-DDT	58	C
S2SB-2	05/93	4,4'-DDT	43	
S2SB-1	05/93	4,4'-DDT	10	C
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SB-4	05/93	Bis(2-ethylhexyl)phthalate	670	
S2SB-2	05/93	Bis(2-ethylhexyl)phthalate	160	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SB-2	05/93	1,1,1,2-tetrachloroethane	1	J
S2SB-2	05/93	1,2,3-trichloropropane	2	J
S2SB-2	05/93	2-butanone	23	
S2SB-2	05/93	Acetone	81	
S2SB-4	05/93	Acetone	29	
S2SB-2	05/93	Cis-1,2-dichloroethene	10	
S2SB-3	05/93	Cis-1,2-dichloroethene	2.7	
S2SB-2	05/93	Methacrylonitrile	160	
S2SB-4	05/93	Methylene chloride	23	B
S2SB-2	05/93	Methylene chloride	12	
S2SB-4	05/93	Xylenes (total)	2	J

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

TABLE 4-36

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 2
NAS KEY WEST
PAGE 1 OF 5

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S2SB-12 (L6)	08/02/95	Aluminum	6,140	E
S2SB-11 (P14)-D	07/26/95	Aluminum	3,650	E
S2SB-13 (D6)	08/02/95	Aluminum	2,590	E
S2SB-11 (P14)	07/20/95	Aluminum	626	E
S2SB-10 (F20)	08/02/95	Aluminum	452	E
S2SB-2	05/93	Antimony	4.7	B
S2SB-11 (P14)	07/20/95	Antimony	0.41	B
S2SB-11 (P14)-D	07/26/95	Antimony	0.36	B
S2SB-13 (D6)	08/02/95	Antimony	0.26	B
S2SB-10 (F20)	08/02/95	Antimony	0.25	B
S2SB-11 (P14)-D	07/26/95	Arsenic	4.2	
S2SB-12 (L6)	08/02/95	Arsenic	2.4	
S2SB-13 (D6)	08/02/95	Arsenic	1.8	
S2SB-2	05/93	Arsenic	1.7	
S2SB-11 (P14)	07/20/95	Arsenic	1.2	
S2SB-3	05/93	Arsenic	0.99	BJ
S2SB-10 (F20)	08/02/95	Arsenic	0.99	
S2SB-4	05/93	Arsenic	0.54	B
S2SB-12 (L6)	08/02/95	Barium	14.9	B
S2SB-11 (P14)-D	07/26/95	Barium	11.6	B
S2SB-13 (D6)	08/02/95	Barium	11.6	B
S2SB-2	05/93	Barium	8.5	B
S2SB-3	05/93	Barium	7.5	BJ
S2SB-10 (F20)	08/02/95	Barium	7.4	B
S2SB-4	05/93	Barium	7.1	B
S2SB-11 (P14)	07/20/95	Barium	5.8	B
S2SB-2	05/93	Beryllium	0.23	B
S2SB-12 (L6)	08/02/95	Beryllium	0.2	B
S2SB-3	05/93	Beryllium	0.17	B
S2SB-13 (D6)	08/02/95	Beryllium	0.14	B
S2SB-11 (P14)-D	07/26/95	Beryllium	0.13	B
S2SB-11 (P14)	07/20/95	Beryllium	0.093	B
S2SB-10 (F20)	08/02/95	Beryllium	0.092	B
S2SB-11 (P14)	07/20/95	Cadmium	1	
S2SB-2	05/93	Cadmium	0.75	
S2SB-11 (P14)-D	07/26/95	Cadmium	0.68	
S2SB-10 (F20)	08/02/95	Cadmium	0.3	B
S2SB-12 (L6)	08/02/95	Cadmium	0.17	B
S2SB-13 (D6)	08/02/95	Cadmium	0.12	B
S2SB-10 (F20)	08/02/95	Calcium	4E+05	E
S2SB-11 (P14)	07/20/95	Calcium	4E+05	E
S2SB-13 (D6)	08/02/95	Calcium	4E+05	E
S2SB-11 (P14)-D	07/26/95	Calcium	3E+05	E
S2SB-12 (L6)	08/02/95	Calcium	3E+05	E
S2SB-13 (D6)	08/02/95	Chromium	11.6	
S2SB-12 (L6)	08/02/95	Chromium	10.2	
S2SB-2	05/93	Chromium	8.3	
S2SB-11 (P14)-D	07/26/95	Chromium	6.3	
S2SB-11 (P14)	07/20/95	Chromium	4.5	
S2SB-3	05/93	Chromium	4.3	
S2SB-10 (F20)	08/02/95	Chromium	4	
S2SB-4	05/93	Chromium	2.9	
S2SB-12 (L6)	08/02/95	Cobalt	0.55	B
S2SB-11 (P14)-D	07/26/95	Cobalt	0.27	B
S2SB-13 (D6)	08/02/95	Cobalt	0.21	B
S2SB-10 (F20)	08/02/95	Cobalt	0.18	B
S2SB-11 (P14)	07/20/95	Cobalt	0.11	B
S2SB-11 (P14)	07/20/95	Copper	8	
S2SB-12 (L6)	08/02/95	Copper	7.6	
S2SB-11 (P14)-D	07/26/95	Copper	5.8	
S2SB-10 (F20)	08/02/95	Copper	4.9	

TABLE 4-36

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S2SB-13 (D6)	08/02/95	Copper	2.3	
S2SB-2	05/93	Copper	1.4	B
S2SB-4	05/93	Copper	1.2	B
S2SB-4	05/93	Cyanide	18	
S2SB-12 (L6)	08/02/95	Iron	1,960	E
S2SB-11 (P14)-D	07/26/95	Iron	1,910	E
S2SB-13 (D6)	08/02/95	Iron	1,170	E
S2SB-11 (P14)	07/20/95	Iron	704	E
S2SB-10 (F20)	08/02/95	Iron	659	E
N10	08/09/95	Lead	55.4	E
R12	08/09/95	Lead	54.9	
Z12	08/09/95	Lead	42.8	
V12	08/09/95	Lead	24.8	
S2SB-10 (F20)	08/02/95	Lead	16.6	E
M9	08/09/95	Lead	16.5	
R10	08/09/95	Lead	13.1	
N6	08/10/95	Lead	11.6	E
R6	08/09/95	Lead	7.8	E
S2SB-11 (P14)	07/20/95	Lead	7.1	E
V10	08/09/95	Lead	6.3	
S2SB-11 (P14)-D	07/26/95	Lead	5.1	E
S2SB-2	05/93	Lead	3.8	
S2SB-4	05/93	Lead	2	
S2SB-12 (L6)	08/02/95	Lead	1.6	E
S2SB-3	05/93	Lead	1.4	
S2SB-13 (D6)	08/02/95	Lead	0.27	E
S2SB-11 (P14)-D	07/26/95	Magnesium	8,890	E
S2SB-13 (D6)	08/02/95	Magnesium	7,230	E
S2SB-12 (L6)	08/02/95	Magnesium	6,660	E
S2SB-10 (F20)	08/02/95	Magnesium	3,380	E
S2SB-11 (P14)	07/20/95	Magnesium	2,400	E
S2SB-12 (L6)	08/02/95	Manganese	20.1	E
S2SB-11 (P14)-D	07/26/95	Manganese	17.5	E
S2SB-13 (D6)	08/02/95	Manganese	15.7	E
S2SB-10 (F20)	08/02/95	Manganese	8.6	E
S2SB-11 (P14)	07/20/95	Manganese	8.4	E
S2SB-12 (L6)	08/02/95	Mercury	0.055	B
S2SB-12 (L6)	08/02/95	Nickel	3.2	B
S2SB-11 (P14)-D	07/26/95	Nickel	1.9	B
S2SB-13 (D6)	08/02/95	Nickel	1.3	B
S2SB-10 (F20)	08/02/95	Nickel	0.78	B
S2SB-11 (P14)	07/20/95	Nickel	0.53	B
S2SB-12 (L6)	08/02/95	Potassium	896	
S2SB-11 (P14)-D	07/26/95	Potassium	618	
S2SB-13 (D6)	08/02/95	Potassium	314	B
S2SB-11 (P14)	07/20/95	Potassium	162	B
S2SB-10 (F20)	08/02/95	Potassium	125	B
S2SB-12 (L6)	08/02/95	Selenium	1.2	N
S2SB-11 (P14)-D	07/26/95	Selenium	0.57	N
S2SB-10 (F20)	08/02/95	Selenium	0.33	BN
S2SB-13 (D6)	08/02/95	Selenium	0.33	BN
S2SB-11 (P14)	07/20/95	Selenium	0.3	BN
S2SB-11 (P14)	07/20/95	Silver	0.15	B
S2SB-12 (L6)	08/02/95	Sodium	6,100	
S2SB-11 (P14)-D	07/26/95	Sodium	3,570	
S2SB-11 (P14)	07/20/95	Sodium	2,360	
S2SB-10 (F20)	08/02/95	Sodium	1,810	
S2SB-13 (D6)	08/02/95	Sodium	1,180	
S2SB-3	05/93	Tin	6.2	BJ
S2SB-10 (F20)	08/02/95	Tin	2	B
S2SB-12 (L6)	08/02/95	Tin	1.4	B

TABLE 4-36

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (mg/kg) (cont.)				
S2SB-11 (P14)	07/20/95	Tin	1	B
S2SB-11 (P14)-D	07/26/95	Tin	0.96	B
S2SB-13 (D6)	08/02/95	Tin	0.71	B
S2SB-12 (L6)	08/02/95	Vanadium	7	B
S2SB-13 (D6)	08/02/95	Vanadium	4.2	B
S2SB-11 (P14)-D	07/26/95	Vanadium	3.3	B
S2SB-2	05/93	Vanadium	3.2	B
S2SB-10 (F20)	08/02/95	Vanadium	2.4	B
S2SB-11 (P14)	07/20/95	Vanadium	2	B
S2SB-3	05/93	Vanadium	1.7	BJ
S2SB-10 (F20)	08/02/95	Zinc	23.3	E
S2SB-11 (P14)	07/20/95	Zinc	10.5	E
S2SB-12 (L6)	08/02/95	Zinc	9.2	E
S2SB-11 (P14)-D	07/26/95	Zinc	7.7	E
S2SB-13 (D6)	08/02/95	Zinc	5.3	E
S2SB-2	05/93	Zinc	3.7	
S2SB-4	05/93	Zinc	2.6	
S2SB-3	05/93	Zinc	1.8	B
PESTICIDES/PCBs (µg/kg)				
L13	04/96	4,4'-DDD	316	D
B9	04/96	4,4'-DDD	207	PD
M13	04/96	4,4'-DDD	197	JD
B15	04/96	4,4'-DDD	122	D
D16	04/96	4,4'-DDD	118	JD
B11	04/96	4,4'-DDD	117	JD
J15	04/96	4,4'-DDD	95	JPD
F8	04/96	4,4'-DDD	90	JD
L13	04/96	4,4'-DDD	85	EP
S2SB-4	05/93	4,4'-DDD	76	DJ
M13	04/96	4,4'-DDD	75	PD
S2SB-4	05/93	4,4'-DDD	58	XF
B9	04/96	4,4'-DDD	54	E
F8	04/96	4,4'-DDD	53	E
H16	04/96	4,4'-DDD	48	PD
H16	04/96	4,4'-DDD	45	PD
B15	04/96	4,4'-DDD	44	D
B11	04/96	4,4'-DDD	43	EP
J15	04/96	4,4'-DDD	32	EP
H16	04/96	4,4'-DDD	29	EP
B15	04/96	4,4'-DDD	22	EP
B15	04/96	4,4'-DDD	21	EP
S2SB-12 (L6)	08/02/95	4,4'-DDD	18	
C8	04/96	4,4'-DDD	15	JPD
D16	04/96	4,4'-DDD	14	P
K9	04/96	4,4'-DDD	13	P
C8	04/96	4,4'-DDD	9	P
I8	04/96	4,4'-DDD	4	P
S2SB-13 (D6)	08/02/95	4,4'-DDD	3.9	J
B9	04/96	4,4'-DDE	1,160	D
K9	04/96	4,4'-DDE	908	D
S2SB-3	05/93	4,4'-DDE	820	C
M13	04/96	4,4'-DDE	642	D
D16	04/96	4,4'-DDE	525	D
M13	04/96	4,4'-DDE	521	E
B15	04/96	4,4'-DDE	464	D
B11	04/96	4,4'-DDE	411	D
J15	04/96	4,4'-DDE	286	D
I8	04/96	4,4'-DDE	266	D
S2SB-4	05/93	4,4'-DDE	260	D
S2SB-4	05/93	4,4'-DDE	210	XF
S2SB-8	05/93	4,4'-DDE	180	C

TABLE 4-36

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
PESTICIDES/PCBs (µg/kg) (cont.)				
B15	04/96	4,4'-DDE	155	D
L13	04/96	4,4'-DDE	137	JPD
S2SB-10 (F20)	08/02/95	4,4'-DDE	130	
C8	04/96	4,4'-DDE	120	D
H16	04/96	4,4'-DDE	120	D
K9	04/96	4,4'-DDE	114	EP
H16	04/96	4,4'-DDE	102	E
B9	04/96	4,4'-DDE	88	EP
D16	04/96	4,4'-DDE	81	EP
B11	04/96	4,4'-DDE	77	EP
B15	04/96	4,4'-DDE	71	EP
B15	04/96	4,4'-DDE	67	EP
J15	04/96	4,4'-DDE	66	EP
I8	04/96	4,4'-DDE	65	EP
L13	04/96	4,4'-DDE	54	EP
C8	04/96	4,4'-DDE	49	EP
H16	04/96	4,4'-DDE	49	EP
S2SB-1	05/93	4,4'-DDE	44	C
S2SB-13 (D6)	08/02/95	4,4'-DDE	34	
F8	04/96	4,4'-DDE	15	E
S2SB-11 (P14)-D	07/26/95	4,4'-DDE	8.3	
F8	04/96	4,4'-DDE	8	JPD
S2SB-11 (P14)	07/20/95	4,4'-DDE	8	
S2SB-12 (L6)	08/02/95	4,4'-DDE	7	
S2SB-3	05/93	4,4'-DDT	4,400	C
B9	04/96	4,4'-DDT	522	D
F8	04/96	4,4'-DDT	480	D
M13	04/96	4,4'-DDT	344	D
M13	04/96	4,4'-DDT	302	D
S2SB-4	05/93	4,4'-DDT	290	D
S2SB-4	05/93	4,4'-DDT	260	XF
K9	04/96	4,4'-DDT	235	D
H16	04/96	4,4'-DDT	228	D
J15	04/96	4,4'-DDT	177	D
H16	04/96	4,4'-DDT	155	E
L13	04/96	4,4'-DDT	150	JPD
S2SB-10 (F20)	08/02/95	4,4'-DDT	150	
B15	04/96	4,4'-DDT	137	D
B11	04/96	4,4'-DDT	100	JPD
S2SB-8	05/93	4,4'-DDT	89	C
K9	04/96	4,4'-DDT	85	E
C8	04/96	4,4'-DDT	83	D
D16	04/96	4,4'-DDT	76	JPD
F8	04/96	4,4'-DDT	76	E
B9	04/96	4,4'-DDT	75	E
H16	04/96	4,4'-DDT	65	E
J15	04/96	4,4'-DDT	63	E
L13	04/96	4,4'-DDT	47	E
C8	04/96	4,4'-DDT	44	E
B15	04/96	4,4'-DDT	42	EP
B11	04/96	4,4'-DDT	40	E
B15	04/96	4,4'-DDT	39	D
B15	04/96	4,4'-DDT	34	EP
S2SB-1	05/93	4,4'-DDT	34	C
D16	04/96	4,4'-DDT	31	E
S2SB-13 (D6)	08/02/95	4,4'-DDT	28	
S2SB-12 (L6)	08/02/95	4,4'-DDT	26	
I8	04/96	4,4'-DDT	9	
S2SB-11 (P14)	07/20/95	4,4'-DDT	5.7	
S2SB-11 (P14)-D	07/26/95	4,4'-DDT	4.2	
F8	04/96	Aldrin	1	J

TABLE 4-36

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 2
NAS KEY WEST
PAGE 5 OF 5

Location	Date	Parameter	Result	Qual.(1)
PESTICIDES/PCBs (µg/kg) (cont.)				
K9	04/96	Aldrin	1	JP
L13	04/96	Aldrin	1	J
B9	04/96	Alpha-BHC	1	J
F8	04/96	Alpha-BHC	1	JP
B15	04/96	Beta-BHC	2	P
B9	04/96	Beta-BHC	2	
D16	04/96	Beta-BHC	2	
B9	04/96	Delta-BHC	1	J
H16	04/96	Delta-BHC	1	J
J15	04/96	Endosulfan I	2	P
C8	04/96	Endosulfan I	1	JP
F8	04/96	Endosulfan I	1	P
K9	04/96	Endosulfan I	1	P
L13	04/96	Endosulfan I	1	P
L13	04/96	Endosulfan II	7	P
F8	04/96	Endosulfan II	1	JP
K9	04/96	Endosulfan sulfate	3	P
L13	04/96	Endrin	7	P
B9	04/96	Endrin	3	P
J15	04/96	Endrin	3	P
K9	04/96	Endrin	3	P
F8	04/96	Endrin	2	P
K9	04/96	Endrin ketone	3	
K9	04/96	Gamma-BHC (lindane)	1	
F8	04/96	Heptachlor epoxide	16	EP
K9	04/96	Heptachlor epoxide	6	P
K9	04/96	Methoxychlor	9	JP
J15	04/96	Methoxychlor	3	JP
K9	04/96	Toxaphene	343	P
I8	04/96	Toxaphene	91	P

Location	Date	Parameter	Result	Qual.(1)
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SB-2	05/93	Bis(2-ethylhexyl)phthalate	310	J
S2SB-4	05/93	Bis(2-ethylhexyl)phthalate	200	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SB-4	05/93	2-butanone	3	J
S2SB-4	05/93	Acetone	47	
S2SB-2	05/93	Acetone	29	
S2SB-2	05/93	Cis-1,2-dichloroethene	8	
S2SB-4	05/93	Cis-1,2-dichloroethene	6	
S2SB-4	05/93	Methylene chloride	27	B
S2SB-2	05/93	Methylene chloride	24	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

pesticide 4,4'-DDT and its degradation products were the most frequently detected contaminants in the soil at the 4,4'-DDT Mixing Area. Inorganic compounds and metals were found on both the northern and southern sides of the site. Figure 4-14 shows the distribution of pesticides in surface soil, and Figure 4-15 shows inorganic chemicals detected in surface soil. Most of the samples obtained at SWMU 2 were from surface soil, although subsurface soil samples were extracted from five borings during the RFI/RI. In general, the subsurface soil had lower frequencies and levels of contaminants, although a few inorganic compounds were detected. Figure 4-16 shows the subsurface distribution of contaminants at the site based on RFI/RI sampling results.

To be conservative, contaminant levels discussed in this section were compared to the most restrictive criteria from several sets of ARARs and SALs, including ORNL BTVs, EPA Region III BTAG BTVs, proposed RCRA Subpart S Action Levels, RPRGs, FDEP Residential Cleanup Goals, and FDEP Industrial Soil Cleanup Goals. These criteria are listed in Table 2-3.

4.2.5.1.1 Volatile Organic Compounds

Several VOCs, including 2-butanone, acetone, methylene chloride, and cis-1,2-DCE, were detected in surface soil at S2SB-2 and S2SB-4 during the RFI/RI. With the exception of a single detection of cis-1,2-DCE at S2SB-3, the detection of VOCs was limited to these two samples and levels were substantially below ARAR/SAL criteria. In addition to these VOCs, several others were found in subsurface samples at the same locations, but again the concentrations were well below ARAR/SAL criteria.

4.2.5.1.2 Semivolatile Organic Compounds

A single SVOC was found in soil at the site during the RFI/RI. Bis(2-ethylhexyl)phthalate was detected in surface and subsurface samples from S2SB-2 and S2SB-4. These are the same sites where low levels of VOCs were identified. Levels of bis(2-ethylhexyl)phthalate were well below the most restrictive ARAR/SAL criteria.

4.2.5.1.3 Pesticides

The pesticide 4,4'-DDT, 4,4'-DDD and 4,4'-DDE, were commonly found in soil samples taken in the immediate vicinity of the area excavated by BEI. Detected levels of 4,4'-DDE were found most often in excess of the 0.1 mg/kg standard in surface soil, followed by 4,4'-DDT. Conversely, 4,4'-DDD was

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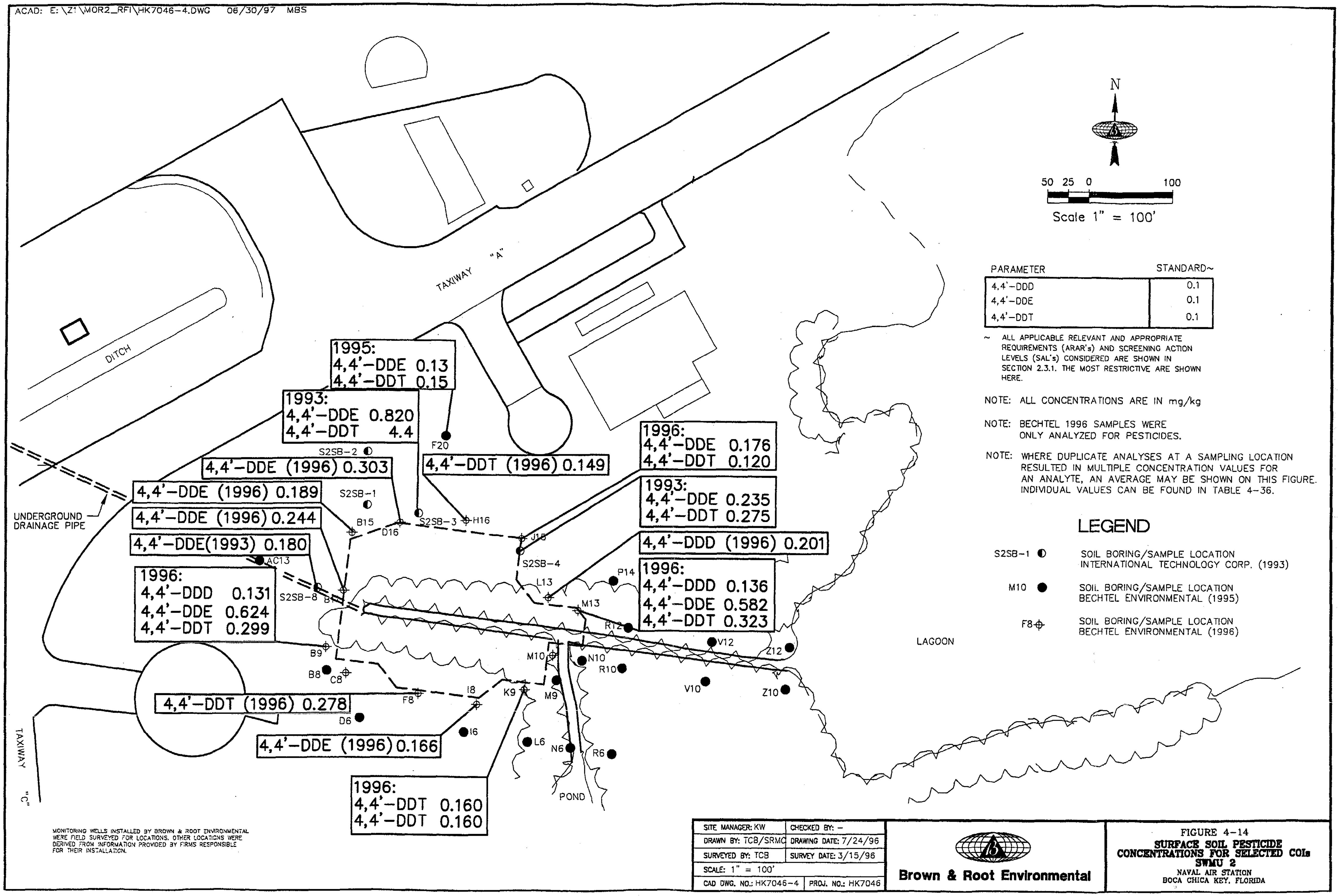

FIGURE 4-14
SURFACE SOIL PESTICIDE CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

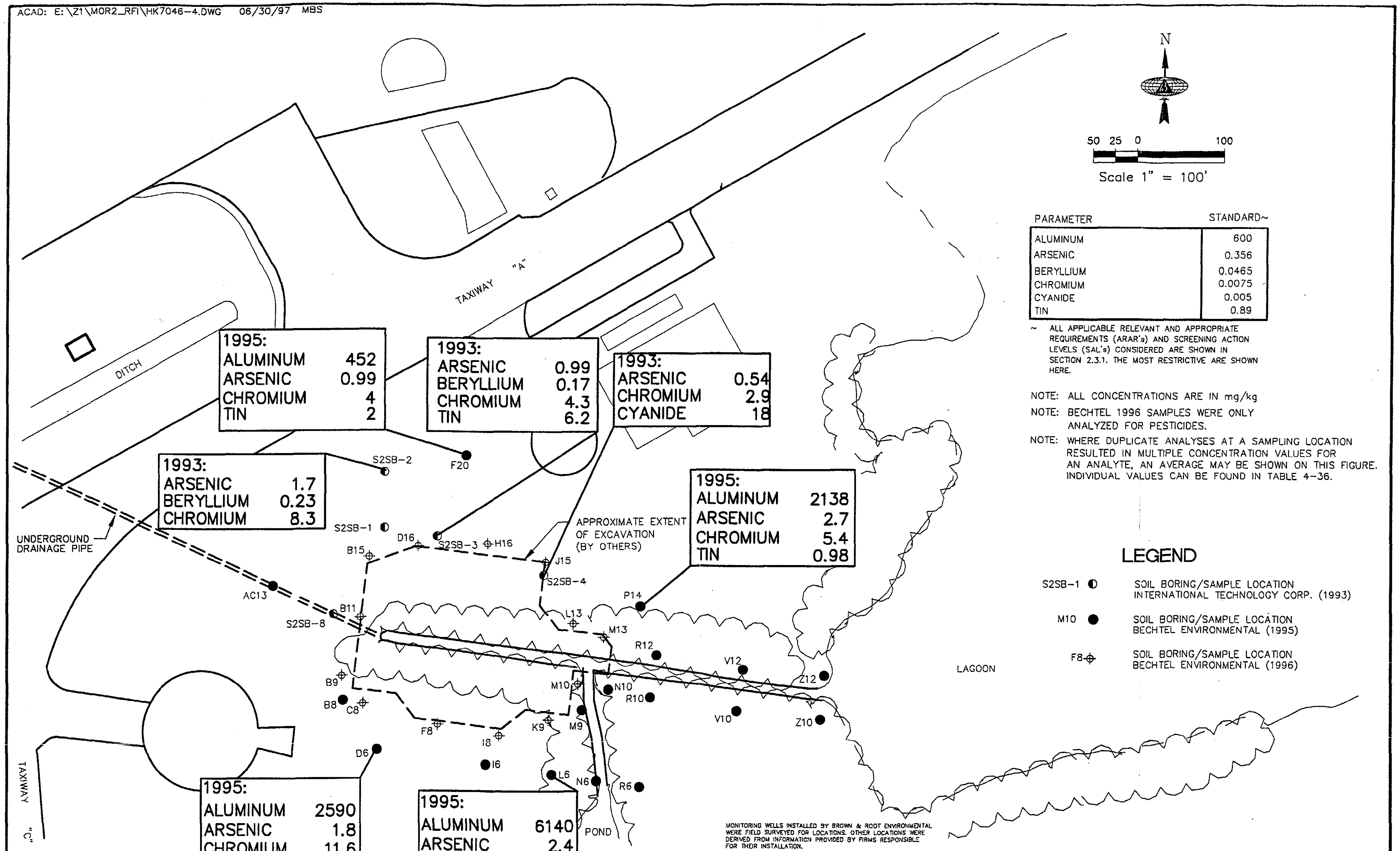

FIGURE 4-15
SURFACE SOIL INORGANIC CONTAMINANT CONCENTRATIONS FOR SELECTED COIs SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

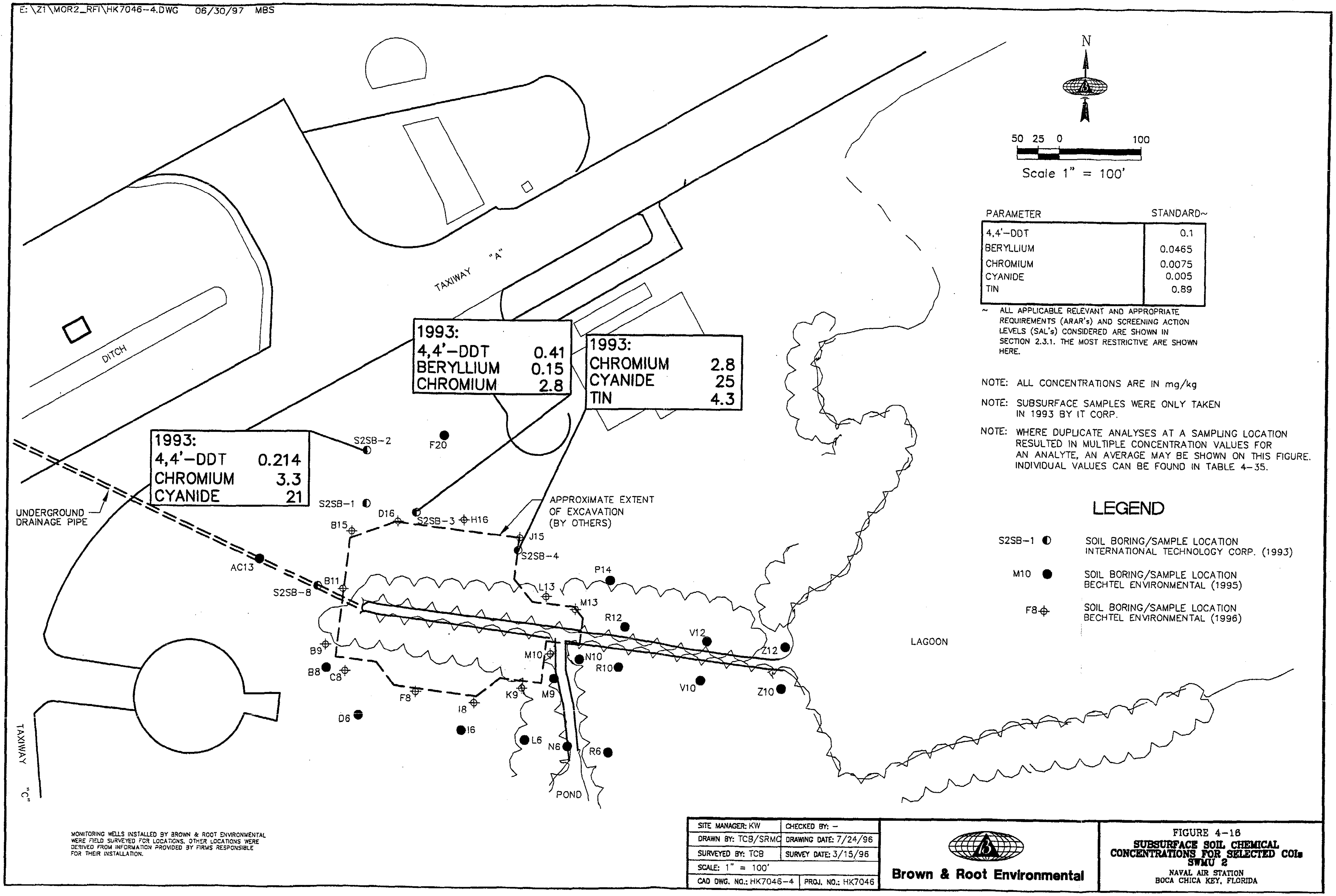

FIGURE 4-18
SUBSURFACE SOIL CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

detected in many of the samples, but exceeded its 0.1 mg/kg ARAR/SAL in only three cases, with the highest concentration, 0.201 mg/kg, found on the east side of the area excavated by BEI. The highest concentrations of 4,4'-DDE and 4,4'-DDT (0.820 mg/kg and 4.4 mg/kg, respectively) were found in the northern portion of the site at S2SB-3. In terms of pesticide distribution in the surface soil at the site, no trend is apparent. The compounds were found around the perimeter of the excavation in comparable quantities. Several delineation soil samples west of the lagoon and north of the pond were tested only for lead content; thus, no conclusions can be drawn about pesticide distributions in soil in those areas.

The subsurface samples analyzed during the RFI/RI for pesticides exceeded ARAR/SAL criteria in two cases; 4,4'-DDT was found in S2SB-2 and S2SB-3 in the northern part of the site. S2SB-3 had the highest subsurface concentration, at 0.41 mg/kg.

4.2.5.1.4 PCBs

No PCBs were detected in the soil at SMWU 2.

4.2.5.1.5 Metals and Inorganics

Metal contamination that exceeded the most restrictive ARAR/SAL criteria was found in surface samples from both the northern and southern regions of the site. Arsenic and chromium were detected in excess of ARAR/SAL criteria with the greatest frequency, with chromium at maximum concentrations (11.6 mg/kg) to the south and arsenic (2.7 mg/kg) to the northeast. Beryllium was detected in six surface samples, tin in five, and aluminum in four. The maximum concentrations were 0.23 mg/kg (S2SB-2), 6.2 mg/kg (S2SB-3), and 6,140 mg/kg (L6), respectively. Cyanide was identified in a single surface sample in the northeastern portion of the site; the concentration of 18 mg/kg exceeded the 0.005 mg/kg EPA Region III BTAG BTV.

Several metals identified in surface samples were also seen in subsurface borings. Beryllium was present in two borings at concentrations slightly less than those seen in surface soil. Chromium was identified in three subsurface samples at locations where it was also a surface contaminant. In each case, the subsurface levels were lower than those found in surface soil. Tin was detected at 4.3 mg/kg in the subsurface sample from S2SB-4, although it was not identified as a surface contaminant at that location. Cyanide was detected in two subsurface samples. Both cyanide detections (21 mg/kg and 25 mg/kg) were above the ARAR/SAL limit, and both exceeded the level detected in the single surface soil sample.

4.2.5.2 Sediment

Chemicals detected in sediment are presented in Table 4-37. Sediment sampling was performed in the main ditch between the excavated area and the lagoon, and in the secondary ditch that runs between the excavated area and the pond. Some sediment sampling occurred during the RFI/RI, although most of the sampling was performed by BEI in 1995 and 1996. Pesticides and metals were the most frequently detected sediment contamination. Figures 4-17, 4-18, and 4-19 show sediment contaminants that exceeded ARAR/SAL criteria in 1993, 1995, and 1996, respectively. The sediment contamination is shown by year to illustrate temporal trends in contamination and reduce any confusion associated with sampling that occurred at the same location during different years.

To be conservative, contaminant levels discussed in this section were compared to the most restrictive of several sets of ARAR/SAL criteria, including Florida Sediment Quality Guidelines, EPA Region IV Sediment Screening Values, Federal Sediment Quality Criteria, proposed RCRA Action Levels, ER-L Criteria, ER-M Criteria, and EPA Sediment Quality Benchmarks. These criteria are presented in Table 2-4.

4.2.5.2.1 Volatile Organic Compounds

Methylene chloride and acetone were the only VOCs detected in the RFI/RI, while acetone, carbon disulfide, and 2-butanone were detected in the delineation sampling. None of the VOCs detected in sediment exceeded the most restrictive ARAR or SAL criteria.

4.2.5.2.2 Semivolatile Organic Compounds

A single SVOC was detected in sediment samples at the 4,4'-DDT mixing area. Bis(2-ethylhexyl)phthalate, the same SVOC found in soil samples, was identified in sediment from S2SS-2 in the RFI/RI. At 2.5 mg/kg, the concentration exceeded the 0.182 mg/kg EPA Region IV sediment screening value; however, the occurrence was isolated.

4.2.5.2.3 Pesticides

Only one RFI/RI sediment sampling location was outside the limits of excavation. The pesticide 4,4'-DDT and both its degradation products were detected in this sample located at the mouth of the ditch.

TABLE 4-37

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 2
NAS KEY WEST
PAGE 1 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S2SS-4SD	08/02/95	Aluminum	740	E
S2SS-1SD(Z11)	08/02/95	Aluminum	669	E
S2SS-1SD(Z11)	08/02/95	Antimony	0.44	B
S2SS-4SD	08/02/95	Antimony	0.42	B
S2SS-4SD	08/02/95	Arsenic	1.5	
S2SS-1SD(Z11)	08/02/95	Arsenic	0.81	B
S2SS-2	05/93	Arsenic	0.72	B
S2SS-1SD(Z11)	08/02/95	Barium	8.7	B
S2SS-4SD	08/02/95	Barium	6.6	B
S2SS-2	05/93	Barium	4.5	B
S2SS-4SD	08/02/95	Beryllium	0.11	B
S2SS-1SD(Z11)	08/02/95	Beryllium	0.09	B
S2SS-4SD	08/02/95	Cadmium	1.6	
S2SS-1SD(Z11)	08/02/95	Cadmium	0.44	B
S2SS-4SD	08/02/95	Calcium	306,000	E
S2SS-1SD(Z11)	08/02/95	Calcium	304,000	E
S2SS-4SD	08/02/95	Chromium	8.1	
S2SS-2	05/93	Chromium	6.8	
S2SS-1SD(Z11)	08/02/95	Chromium	3	
S2SS-4SD	08/02/95	Cobalt	0.87	B
S2SS-1SD(Z11)	08/02/95	Cobalt	0.14	B
S2SS-4SD	08/02/95	Copper	15.3	
S2SS-2	05/93	Copper	10.1	
S2SS-1SD(Z11)	08/02/95	Copper	8	
S2SS-4SD	08/02/95	Iron	2,630	E
S2SS-1SD(Z11)	08/02/95	Iron	1,090	E
R11	08/02/95	Lead	53.8	E
V11	08/02/95	Lead	34.9	E
S2SS-4SD	08/02/95	Lead	31.7	E
M10	08/09/95	Lead	25.1	E
S2SS-2	05/93	Lead	24	
S2SS-1SD(Z11)	08/02/95	Lead	12.8	E
P6	08/09/95	Lead	12	E
S2SS-4SD	08/02/95	Magnesium	2,030	E
S2SS-1SD(Z11)	08/02/95	Magnesium	1,530	E
S2SS-4SD	08/02/95	Manganese	14	E
S2SS-1SD(Z11)	08/02/95	Manganese	9.6	E
S2SS-2	05/93	Mercury	0.05	
S2SS-4SD	08/02/95	Mercury	0.04	B
S2SS-1SD(Z11)	08/02/95	Nickel	3.3	B
S2SS-4SD	08/02/95	Nickel	1.4	B
S2SS-4SD	08/02/95	Potassium	277	B
S2SS-1SD(Z11)	08/02/95	Potassium	215	B
S2SS-1SD(Z11)	08/02/95	Selenium	0.56	BN
S2SS-4SD	08/02/95	Selenium	0.44	BN
S2SS-4SD	08/02/95	Sodium	4,670	
S2SS-1SD(Z11)	08/02/95	Sodium	4,090	
S2SS-2	05/93	Sulfide	1,200	
S2SS-4SD	08/02/95	Tin	1.8	B
S2SS-1SD(Z11)	08/02/95	Tin	1.6	B
S2SS-4SD	08/02/95	Vanadium	4.5	B
S2SS-2	05/93	Vanadium	2.9	B
S2SS-1SD(Z11)	08/02/95	Vanadium	2.5	B
S2SS-2	05/93	Zinc	170	
S2SS-4SD	08/02/95	Zinc	36.1	E
S2SS-1SD(Z11)	08/02/95	Zinc	33.3	E

TABLE 4-37

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
PESTICIDES/PCBs (µg/kg)				
E11	04/96	4,4'-DDD	17,200	D
E11	04/96	4,4'-DDD	10,600	E
M11	04/96	4,4'-DDD	7,120	D
M11	04/96	4,4'-DDD	5,340	E
M10	08/09/95	4,4'-DDD	2,600	
R11	08/02/95	4,4'-DDD	1,400	
S2SS-4SD	08/02/95	4,4'-DDD	700	
P6	08/09/95	4,4'-DDD	700	
S2SS-2	05/93	4,4'-DDD	440	D
S2SS-2	05/93	4,4'-DDD	370	XF
V11	08/02/95	4,4'-DDD	280	
M10	04/96	4,4'-DDD	138	PD
M10	04/96	4,4'-DDD	136	DP
M10	04/96	4,4'-DDD	67	E
R11	08/02/95	4,4'-DDE	4,900	
E11	04/96	4,4'-DDE	4,640	PD
E11	04/96	4,4'-DDE	4,620	PD
M10	08/09/95	4,4'-DDE	2,100	
V11	08/02/95	4,4'-DDE	1,700	
M11	04/96	4,4'-DDE	1,560	PD
S2SS-4SD	08/02/95	4,4'-DDE	1,400	
M11	04/96	4,4'-DDE	1,200	JPD
P6	08/09/95	4,4'-DDE	980	
S2SS-2	05/93	4,4'-DDE	170	XF
S2SS-2	05/93	4,4'-DDE	170	DJX
M10	04/96	4,4'-DDE	77	D
M10	04/96	4,4'-DDE	69	D
M10	04/96	4,4'-DDE	32	EP

Location	Date	Parameter	Result	Qual.(1)
E11	04/96	4,4'-DDT	14,800	D
E11	04/96	4,4'-DDT	10,300	E
S2SS-4SD	08/02/95	4,4'-DDT	5,100	
S2SS-1SD(Z11)	08/02/95	4,4'-DDT	5,000	
M11	04/96	4,4'-DDT	1,830	JD
M10	08/09/95	4,4'-DDT	1,600	
M11	04/96	4,4'-DDT	1,440	D
R11	08/02/95	4,4'-DDT	720	
P6	08/09/95	4,4'-DDT	600	
M10	04/96	4,4'-DDT	181	E
M10	04/96	4,4'-DDT	167	D
M10	04/96	4,4'-DDT	61	EP
S2SS-2	05/93	4,4'-DDT	16	J
M10	04/96	Aldrin	1	P
M11	04/96	Delta- BHC	159	JD
M10	04/96	Delta- BHC	2	
E11	04/96	Delta-BHC	231	JD
M10	04/96	Dieldrin	11	P
E11	04/96	Endosulfan I	359	PD
M10	04/96	Endosulfan I	9	DP
M10	04/96	Endosulfan I	2	P
M10	04/96	Endosulfan sulfate	8	P
E11	04/96	Endrin	244	JPD
M10	04/96	Endrin	142	DP
M10	04/96	Endrin	43	EP
M10	04/96	Gamma-BHC (lindane)	1	
M10	04/96	Heptachlor epoxide	34	EP
M10	04/96	Methoxychlor	104	EP
M10	04/96	Toxaphene	355	P

TABLE 4-37

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 2
NAS KEY WEST
PAGE 3 OF 3

Location	Date	Parameter	Result	Qual.[1]
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SS-2	05/93	Bis(2-ethylhexyl)phthalate	2,500	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S2SS-4SD	08/02/95	2-butanone	10	J
S2SS-4SD	08/02/95	Acetone	51	
S2SS-1SD(Z11)	08/02/95	Acetone	26	
S2SS-2	05/93	Acetone	11	J
S2SS-4SD	08/02/95	Carbon disulfide	10	
S2SS-2	05/93	Methylene chloride	23	B

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-4).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

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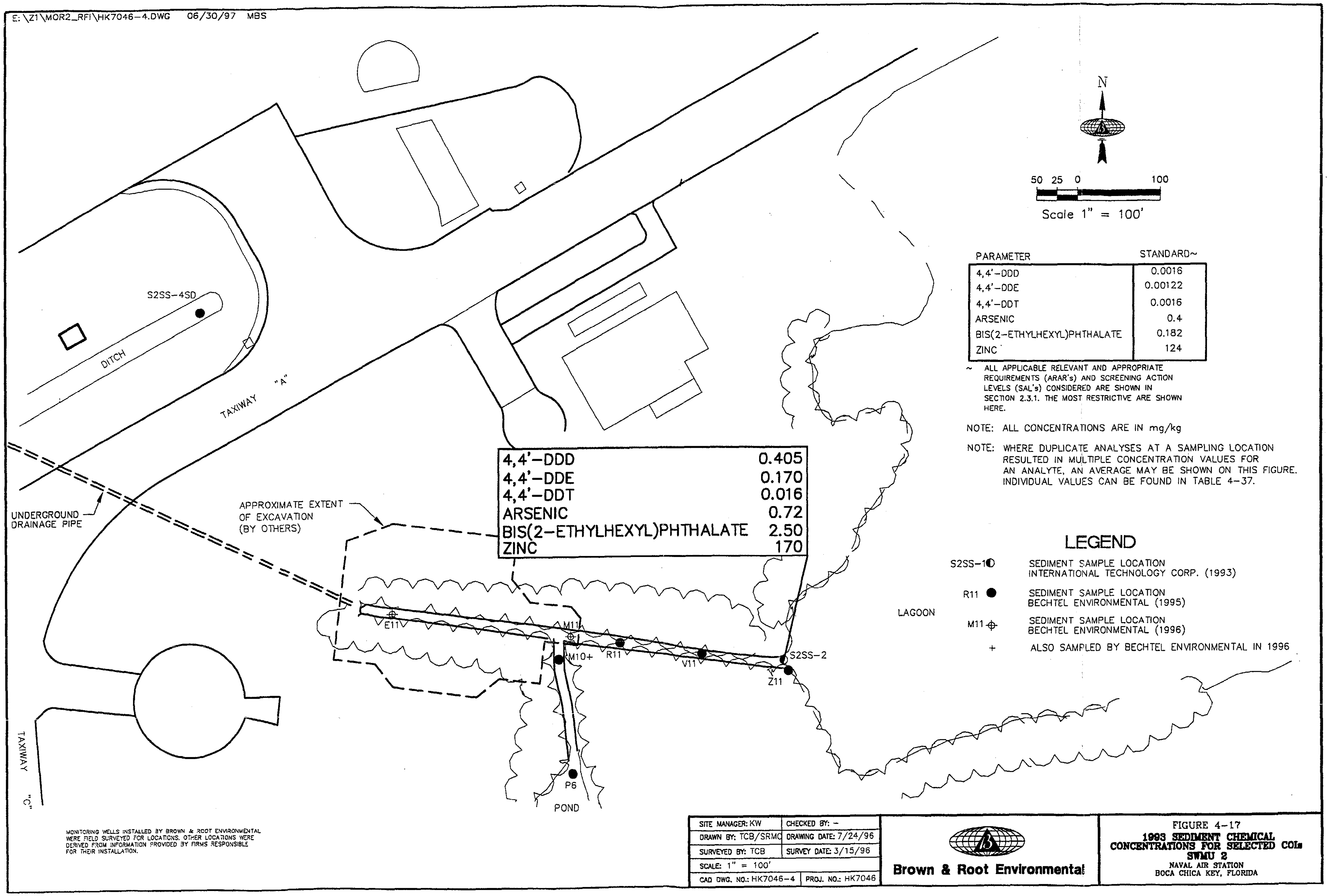
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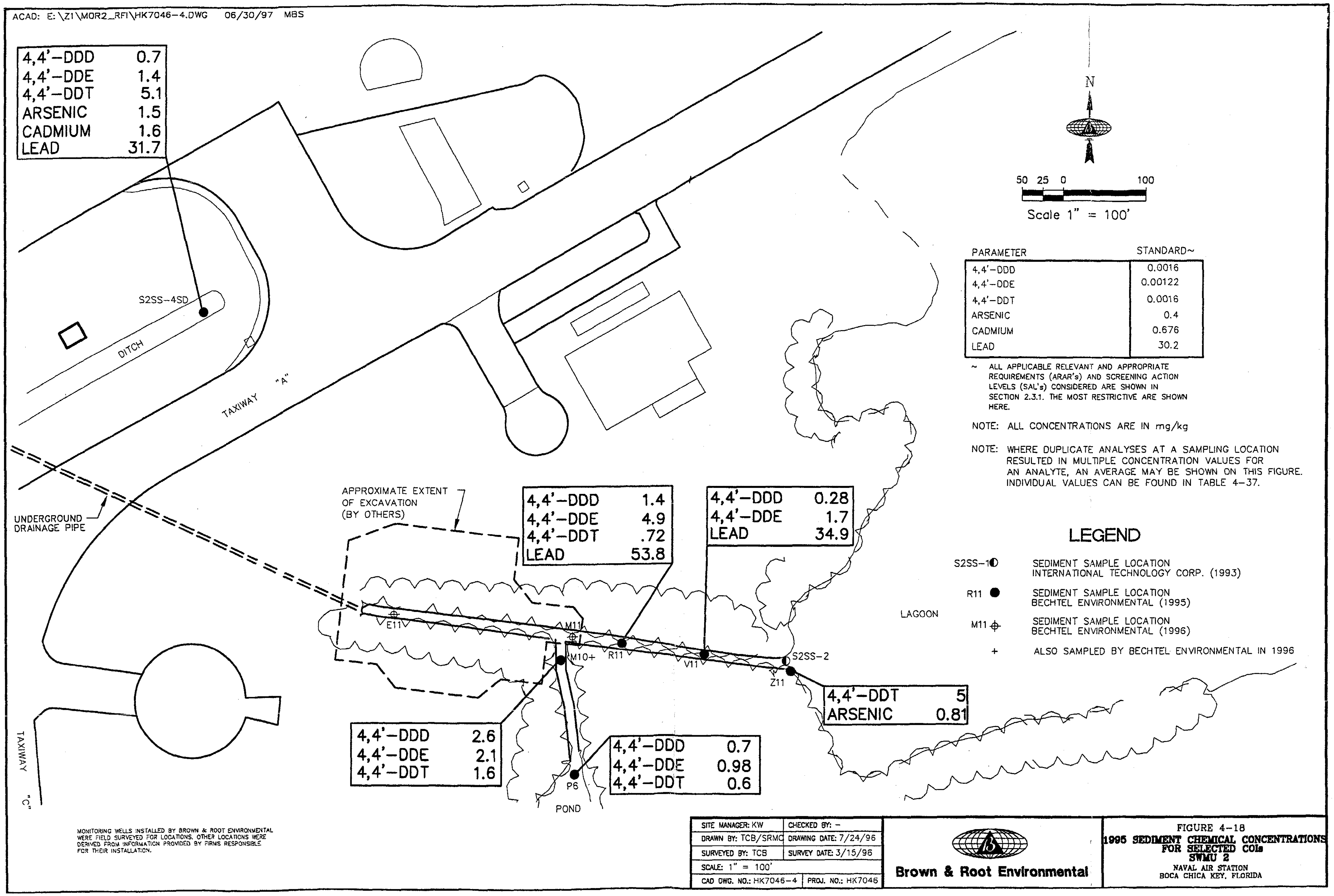
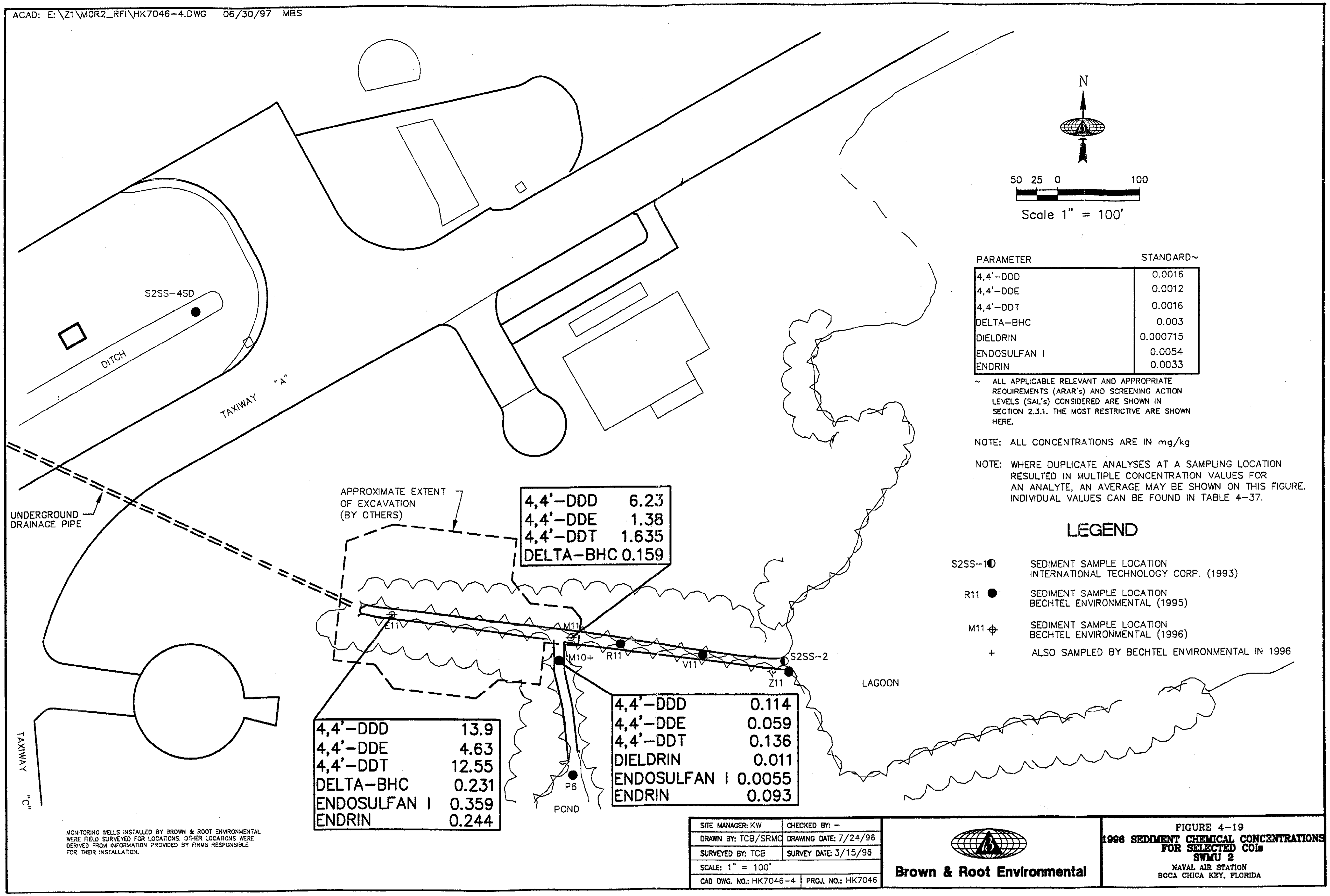
BIS(2-ETHYLHEXYL)PHTHALATE 0.182
ZINC 124
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-37.
LEGEND
S2SS-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
R11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
M11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996
S2SS-4SD
DITCH
TAXIWAY "A"
UNDERGROUND DRAINAGE PIPE
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
4,4'-DDD 0.405
4,4'-DDE 0.170
4,4'-DDT 0.016
ARSENIC 0.72
BIS(2-ETHYLHEXYL)PHTHALATE 2.50
ZINC 170
LAGOON
E11
M11
M10+
R11
V11
S2SS-2
Z11
P6
POND
TAXIWAY "C"
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-4
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-17
1993 SEDIMENT CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


ACAD: E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS
4,4'-DDD 0.7
4,4'-DDE 1.4
4,4'-DDT 5.1
ARSENIC 1.5
CADMIUM 1.6
LEAD 31.7
S2SS-4SD
DITCH
TAXIWAY "A"
UNDERGROUND DRAINAGE PIPE
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
4,4'-DDD 1.4
4,4'-DDE 4.9
4,4'-DDT .72
LEAD 53.8
4,4'-DDD 0.28
4,4'-DDE 1.7
LEAD 34.9
E11
M11
M10+
R11
V11
S2SS-2
Z11
4,4'-DDT 5
ARSENIC 0.81
4,4'-DDD 2.6
4,4'-DDE 2.1
4,4'-DDT 1.6
4,4'-DDD 0.7
4,4'-DDE 0.98
4,4'-DDT 0.6
P6
POND
TAXIWAY "C"
LAGOON
N
50 25 0 100
Scale 1" = 100'
PARAMETER STANDARD~
4,4'-DDD 0.0016
4,4'-DDE 0.00122
4,4'-DDT 0.0016
ARSENIC 0.4
CADMIUM 0.676
LEAD 30.2
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-37.
LEGEND
S2SS-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
R11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
M11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-4
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-18
1995 SEDIMENT CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


ACAD: E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS
N
50 25 0 100
Scale 1" = 100'
PARAMETER STANDARD~
4,4'-DDD 0.0016
4,4'-DDE 0.0012
4,4'-DDT 0.0016
DELTA-BHC 0.003
DIELDRIN 0.000715
ENDOSULFAN I 0.0054
ENDRIN 0.0033
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-37.
LEGEND
S2SS-1 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
R11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
M11 SEDIMENT SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1996)
+ ALSO SAMPLED BY BECHTEL ENVIRONMENTAL IN 1996
S2SS-4SD
DITCH
TAXIWAY "A"
UNDERGROUND DRAINAGE PIPE
APPROXIMATE EXTENT OF EXCAVATION (BY OTHERS)
4,4'-DDD 6.23
4,4'-DDE 1.38
4,4'-DDT 1.635
DELTA-BHC 0.159
E11
M11
M10+
R11
V11
S2SS-2
Z11
LAGOON
4,4'-DDD 13.9
4,4'-DDE 4.63
4,4'-DDT 12.55
DELTA-BHC 0.231
ENDOSULFAN I 0.359
ENDRIN 0.244
4,4'-DDD 0.114
4,4'-DDE 0.059
4,4'-DDT 0.136
DIELDRIN 0.011
ENDOSULFAN I 0.0055
ENDRIN 0.093
P6
POND
TAXIWAY "C"
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: –
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 3/15/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-4
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-19
1996 SEDIMENT CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 2
NAVAL AIR STATION BOCA CHICA KEY, FLORIDA

Delineation samples detected 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT at varying levels throughout both ditches. The highest concentrations of these three pesticides existed closest to the excavation boundaries and at the mouth of the main ditch near the lagoon. These pesticides were also identified in a sediment sample from the northwestern part of the site near Taxiway "A" The 4,4'-DDT concentration in this sample (5.1 mg/kg) was the highest found among the delineation samples. Two post-excavation sediment samples from inside the excavated area were analyzed as part of the confirmation sampling. 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were found in both of these samples. The western-most sample (E11) contained the highest concentrations of 4,4'-DDD (13.9 mg/kg), 4,4'-DDE (4.63 mg/kg), and 4,4'-DDT (12.55 mg/kg). On the eastern side of the excavation (M11), concentrations were above ARAR/SAL levels, but were much less than those at E11. At the southern edge of the excavation (M10) the secondary ditch was sampled by BEI before and after excavation. Confirmation sample results were much lower than those documented in the delineation, although they still exceeded the most restrictive ARAR/SAL limits. Several other pesticides (delta-BHC, endosulfan I, and endrin) were detected near the excavation boundaries in 1996. Like 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE, the highest levels of these pesticides were found in the confirmation sample from E11 at the western end of the main ditch. In addition, aldrin, endosulfan sulfate, gamma-BHC, heptachlor epoxide, methoxychlor, and toxaphene were all detected at M10 during confirmation sampling, although only 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin and endrin exceeded their associated ARAR/SAL criteria.

4.2.5.2.4 PCBs

No PCBs were detected in the sediment at SMWU 2.

4.2.5.2.5 Metals and Inorganics

Zinc and arsenic were detected in a sediment sample taken near the mouth of the main ditch during the RFI/RI. Both metals slightly exceeded their associated ARAR or SAL limit. While arsenic was detected in the same area at a similar concentration during the delineation sampling, zinc was not. Arsenic (1.5 mg/kg) was also found in sediment from S2SS-4SD in the northeastern portion of the site during delineation sampling. The other two metals detected in excess of ARARs and SALs during delineation sampling were lead and cadmium. Cadmium was isolated, occurring at 1.6 mg/kg in a single sample. Lead was detected in the same sample (S2SS-4SD) where arsenic was found, and was detected at two other locations as well. The maximum lead concentration of 53.8 mg/kg occurred at R11, between the excavated area and the lagoon. Confirmation sampling did not include analyses for metals or other inorganics.

4.2.5.3 Surface Water

Chemicals detected in surface water are presented in Table 4-38. Surface water was sampled during the Preliminary RI, the RFI/RI, and delineation sampling events. Preliminary RI samples were analyzed only for inorganics and pesticides, while the RFI/RI samples were tested for VOCs, SVOCs, inorganics, and pesticides. The delineation sampling included analyses for metals, pesticides, and VOCs. Several metals and pesticides were detected above the ARAR/SAL criteria for surface water, but most of the contamination appears to be isolated. The surface-water contamination is shown in Figure 4-20.

To be conservative, FDEP Surface Water Criteria, EPA Surface Water Criteria, National Surface Water Criteria, and Region III Marine and Fresh Water Criteria were all considered as ARARs/ SALs. The most restrictive level from these criteria was compared to each chemical concentration discussed in this section. The criteria are presented in Table 2-5.

4.2.5.3.1 Volatile Organic Compounds

Acetone and methylene chloride, also seen in soil and sediment at low levels, were the only VOCs detected in surface water at the 4,4'-DDT Mixing Area. Acetone was found in a single sample from the Preliminary RI and did not approach the proposed RCRA Action Level of 4,000 μg/L. Methylene chloride was found at S-1 and S-2 at a level (1 μg/L) below the 5 μg/L proposed RCRA Action Level.

4.2.5.3.2 Semivolatile Organic Compounds

Benzylalcohol was the only SVOC detected in the surface water at the 4,4'-DDT Mixing Area. It was detected at S-2 at a concentration of 5 μg/L.

4.2.5.3.3 Pesticides

Concentrations of several pesticides exceeded the most restrictive ARAR/SAL levels in surface-water samples from the 4,4'-DDT Mixing Area. 4,4'-DDD was detected twice with its maximum concentration (1.45 μg/L) occurring at H11. Heptachlor was identified in a single sample (S-1) at 0.064 μg/L. Beta-BHC was detected in the same sample at a concentration higher than the most restrictive ARAR/SAL criteria. 4,4'-DDT was also found in a single sample (H11) at a concentration of 0.33 μg/L. The samples containing these pesticides were from inside the area that was later excavated. The single sample taken from outside that area, near the mouth of the main ditch in 1993, did not contain any detectable amount of pesticides.

TABLE 4-38

CONTAMINANTS DETECTED IN SURFACE WATER - SWMU 2
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (µg/L)				
S-2	05/91	Aluminum	1,510	
S-1	05/91	Aluminum	44.5	B
H11	08/03/95	Aluminum	33.9	B
S2SS-2	05/93	Antimony	13	
S-1	05/91	Barium	16.3	B
S-2	05/91	Barium	15.6	B
H11	08/03/95	Barium	9.8	B
H11	08/03/95	Beryllium	0.21	B
S-1	05/91	Calcium	246,000	
S-2	05/91	Calcium	242,000	
H11	08/03/95	Calcium	123,000	E
S-2	05/91	Iron	236	E
S-1	05/91	Iron	112	E
H11	08/03/95	Iron	63.1	B
S-1	05/91	Lead	53.6	
S-1	05/91	Magnesium	819,000	
S-2	05/91	Magnesium	792,000	
H11	08/03/95	Magnesium	343,000	E
H11	08/03/95	Manganese	4.1	B
H11	08/03/95	Mercury	0.068	B
S-1	05/91	Potassium	232,000	
S-2	05/91	Potassium	220,000	
S2SS-2	08/03/95	Potassium	149,000	E
S-2	05/91	Silver	8.2	B
S-1	05/91	Silver	6.8	B
S-1	05/91	Sodium	6,590,000	
S-2	05/91	Sodium	6,410,000	
H11	08/03/95	Sodium	3,100,000	
S2SS-2	05/93	Tin	10	B
H11	08/03/95	Vanadium	1.65	B
S-2	05/91	Zinc	36.6	
S-1	05/91	Zinc	22.4	
H11	08/03/95	Zinc	2	B
PESTICIDES/PCBs (µg/L)				
S-2	05/91	4,4'-DDD	0.24	
H11	08/03/95	4,4'-DDD	1.45	
H11	08/03/95	4,4'-DDT	0.33	
S-1	05/91	Aldrin	0.11	DZ
S-1	05/91	Beta-BHC	0.15	D
S-1	05/91	Heptachlor	0.064	DJ
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)				
S-2	05/91	Benzyl alcohol	5	J
VOLATILE ORGANIC COMPOUNDS (µg/L)				
S-2	05/91	Acetone	13	
S-1	05/91	Methylene chloride	1	BJ
S-2	05/91	Methylene chloride	1	BJ

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-5).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

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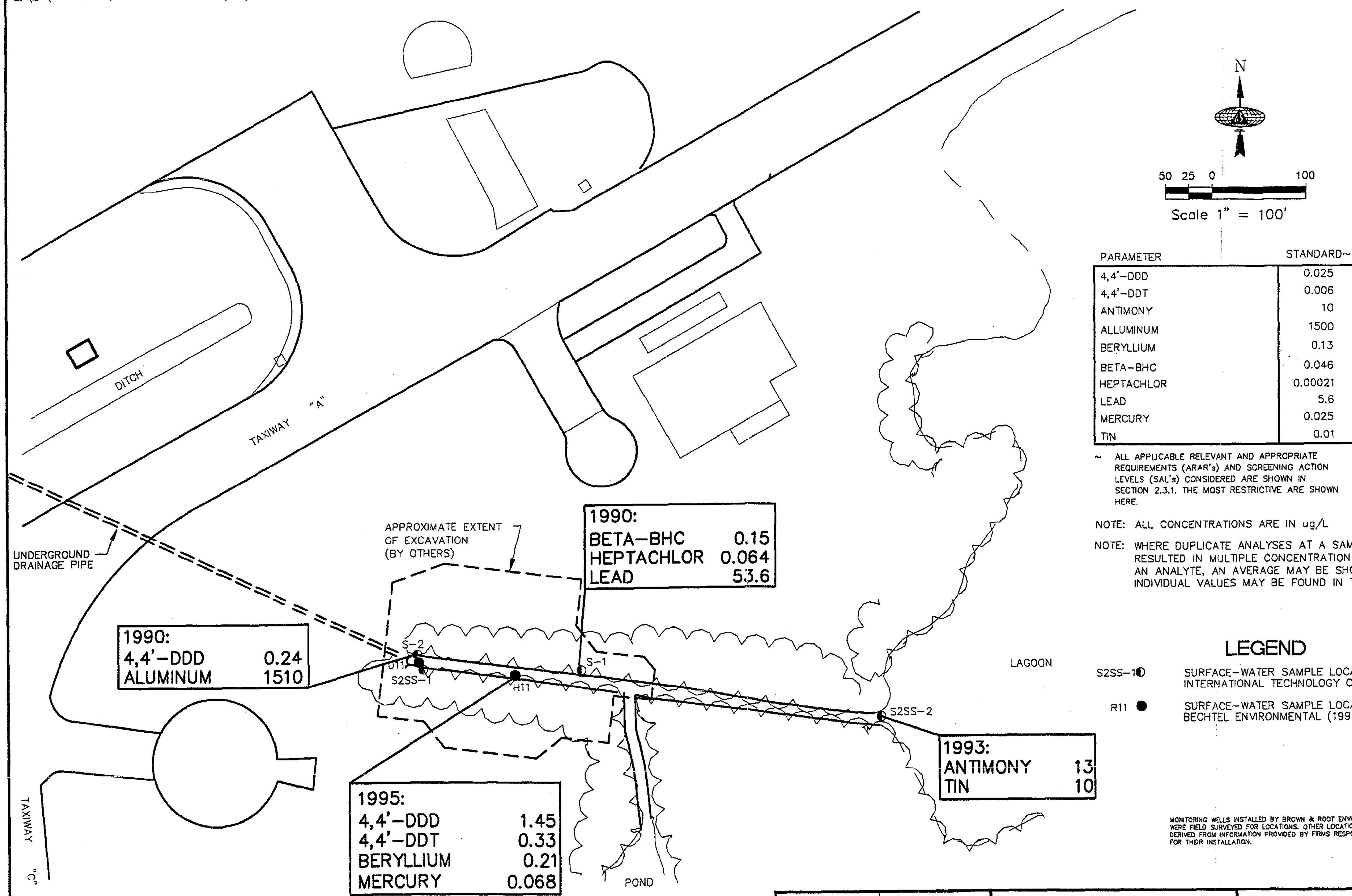

PARAMETER	STANDARD~
4,4'-DDD	0.025
4,4'-DDT	0.006
ANTIMONY	10
ALLUMINUM	1500
BERYLLIUM	0.13
BETA-BHC	0.046
HEPTACHLOR	0.00021
LEAD	5.6
MERCURY	0.025
TIN	0.01

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-38.

LEGEND

S2SS-1 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)

R11 SURFACE-WATER SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-20
SURFACE-WATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.2.5.3.4 PCBs

No PCBs were detected in the surface water at SMWU 2.

4.2.5.3.5 Metals and Inorganics

Aluminum, antimony, beryllium, lead, mercury and tin were all detected in excess of ARAR/SAL criteria at SWMU 2; however, each exceeded its associated ARAR or SAL in only one sample. At 1,510 µg/L in the eastern end of the main ditch, aluminum was slightly over its 1,500-µg/L FDEP Surface Water Quality Criterion. Lead was found in the sample from S-2 at a concentration of 53.6 µg/L. Beryllium (0.21 µg/L) and mercury (0.068 µg/L) were both detected in the delineation surface-water sample from H11. These samples were all taken from inside the area that was later excavated. Antimony and tin were the only inorganic contaminants found at levels surpassing ARAR/SAL limits in the sample taken outside the future excavation, at the mouth of the main ditch. Tin, at a concentration of 10 µg/L, was in excess of the 0.01 µg/L EPA Region III Marine criterion, and antimony (13 µg/L) slightly exceeded the RCRA Action Level of 10 µg/L.

4.2.5.4 Groundwater

Chemicals detected in groundwater are listed in Table 4-39. To be conservative, although the groundwater underlying the site is designated G-III (nonpotable), SDWA MCLs, Florida MCLs, FDEP Guidance Concentrations, and proposed RCRA Action Levels were all considered as ARARs/SALs. The most restrictive criteria were used to evaluate the nature and extent of groundwater contamination in this section; those criteria are presented in Table 2-6.

VOCs, SVOCs, pesticides, and inorganics were detected in groundwater samples, but (like other media at SWMU 2) pesticides were the compounds that most often exceeded ARAR/SAL limits. This observation is based on sampling results from the Preliminary RI, the RFI/RI, and the Supplemental RFI/RI. The Supplemental RFI/RI samples were tested only for pesticides and metals. The chemical distributions are shown in Figures 4-21, 4-22, and 4-23 for the Preliminary RI, the RFI/RI, and the Supplemental RFI/RI, respectively.

TABLE 4-39

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 2
NAS KEY WEST
PAGE 1 OF 4

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (µg/L)				
MW5-2	05/90	Aluminum	3,000	
MW5-3	05/90	Aluminum	1,010	
MW5-1	05/90	Aluminum	717	
S2MW-2	05/93	Antimony	88	
MW5-1	05/93	Antimony	56.6	B
MW5-3	05/93	Antimony	55.7	BJ
MW5-2	05/93	Antimony	42.3	BJ
S2MW-3	05/93	Antimony	41	B
MW5-1	05/93	Arsenic	24.65	
MW5-1	1/28/96	Arsenic	21.4	
S2MW-7	1/28/96	Arsenic	14.5	
S2MW-5	1/28/96	Arsenic	11.2	
S2MW-6	1/28/96	Arsenic	10.9	
MW5-2	05/93	Arsenic	8.2	BJ
S2MW-2	05/93	Arsenic	6.5	BJ
MW5-3	05/93	Arsenic	4.8	BJ
S2MW-3	05/93	Arsenic	2.6	BJ
MW5-2	05/90	Barium	52.3	B
MW5-3	05/90	Barium	44.3	B
MW5-1	05/93	Barium	40.45	B
S2MW-6	1/28/96	Barium	34.3	J
MW5-2	05/93	Barium	28.2	BJ
S2MW-2	05/93	Barium	27.5	BJ
S2MW-3	05/93	Barium	26.4	BJ
MW5-3	05/93	Barium	25.9	BJ
S2MW-5	1/28/96	Barium	21.1	J
S2MW-7	1/28/96	Barium	18.7	J
MW5-1	1/28/96	Barium	12.6	J

Location	Date	Parameter	Result	Qual.[1]
MW5-1	05/93	Beryllium	1.1	B
MW5-2	05/90	Calcium	1,460,000	
MW5-3	05/90	Calcium	1,410,000	
MW5-1	05/90	Calcium	1,210,000	
S2MW-6	1/28/96	Calcium	243,000	J
S2MW-7	1/28/96	Calcium	210,000	J
S2MW-5	1/28/96	Calcium	192,000	J
MW5-1	1/28/96	Calcium	147,000	J
MW5-2	05/90	Chromium	33.7	
S2MW-3	05/93	Chromium	18.6	
MW5-1	05/93	Chromium	16.1	
S2MW-2	05/93	Chromium	15.4	
MW5-2	05/93	Chromium	15	
MW5-3	05/93	Chromium	12.1	
MW5-1	1/28/96	Cyanide	14.2	
MW5-2	05/90	Iron	1,700	
MW5-3	05/90	Iron	524	
MW5-1	05/90	Iron	497	
S2MW-6	1/28/96	Iron	179	J
S2MW-5	1/28/96	Iron	90.8	J
MW5-2	05/93	Lead	5.4	J
MW5-1	05/93	Lead	4	B
S2MW-3	05/93	Lead	3.3	BJ
S2MW-2	05/93	Lead	2.5	BJ
S2MW-6	1/28/96	Magnesium	719,000	
S2MW-7	1/28/96	Magnesium	653,000	
S2MW-5	1/28/96	Magnesium	585,000	
MW5-1	1/28/96	Magnesium	246,000	
MW5-3	05/90	Magnesium	190,000	

TABLE 4-39

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 2
NAS KEY WEST
PAGE 2 OF 4

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (µg/L) (cont.)				
MW5-1	05/90	Magnesium	163,000	
MW5-2	05/90	Magnesium	159,000	
S2MW-5	1/28/96	Manganese	25.1	J
MW5-2	05/90	Manganese	18.8	
MW5-3	05/90	Manganese	13.9	B
S2MW-6	1/28/96	Manganese	11.8	J
MW5-1	1/28/96	Manganese	2.7	J
MW5-2	05/93	Mercury	0.25	
MW5-3	05/93	Mercury	0.22	
MW5-1	05/93	Mercury	0.185	
S2MW-5	1/28/96	Mercury	0.13	
S2MW-7	1/28/96	Mercury	0.13	
S2MW-6	1/28/96	Potassium	178,000	
S2MW-7	1/28/96	Potassium	169,000	
S2MW-5	1/28/96	Potassium	153,000	
MW5-1	1/28/96	Potassium	84,500	
MW5-3	05/90	Potassium	63,900	
MW5-1	05/90	Potassium	60,500	
MW5-2	05/90	Potassium	51,500	
S2MW-6	1/28/96	Sodium	6,010,000	
S2MW-7	1/28/96	Sodium	5,460,000	
S2MW-5	1/28/96	Sodium	4,830,000	
MW5-1	1/28/96	Sodium	2,070,000	
MW5-3	05/90	Sodium	1,620,000	
MW5-1	05/90	Sodium	1,570,000	
MW5-2	05/90	Sodium	1,460,000	
MW5-1	05/93	Sulfide	47,750	
S2MW-7	1/28/96	Thallium	11.7	J
S2MW-6	1/28/96	Thallium	10.5	J
S2MW-5	1/28/96	Thallium	6.7	J
S2MW-3	05/93	Tin	81.9	BJ
MW5-2	05/93	Tin	48.4	BJ
MW5-2	05/90	Zinc	49	
S2MW-3	05/93	Zinc	28.4	
MW5-1	05/90	Zinc	26.8	
MW5-2	05/93	Zinc	17.4	B
MW5-1	05/93	Zinc	16.5	B
MW5-3	05/93	Zinc	8.7	B
S2MW-2	05/93	Zinc	8.3	B
PESTICIDES/PCBs (µg/L)				
MW5-1	05/93	4,4'-DDD	56	D
MW5-1	1/28/96	4,4'-DDD	12.7	
MW5-2	05/90	4,4'-DDD	9.3	D
S2MW-2	05/93	4,4'-DDD	7.8	C
MW5-2	05/93	4,4'-DDD	2.5	C
MW5-3	05/93	4,4'-DDD	1.3	C
MW5-3	05/90	4,4'-DDD	0.76	
MW5-1	05/90	4,4'-DDE	22	*
MW5-1	05/93	4,4'-DDE	4.25	DJX
MW5-2	05/90	4,4'-DDE	1.5	
MW5-2	05/93	4,4'-DDE	0.96	C
S2MW-2	05/93	4,4'-DDE	0.67	C
MW5-3	05/93	4,4'-DDE	0.19	C
MW5-3	05/90	4,4'-DDE	0.16	
S2MW-3	05/93	4,4'-DDE	0.07	C
S2MW-5	1/28/96	4,4'-DDE	0.044	J
MW5-1	05/90	4,4'-DDT	30	*

TABLE 4-39

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 2
NAS KEY WEST
PAGE 3 OF 4

Location	Date	Parameter	Result	Qual.(1)
PESTICIDES/PCBs (μg/L) (cont.)				
MW5-1	05/93	4,4'-DDT	9.45	D
S2MW-6	1/28/96	4,4'-DDT	4.8	
S2MW-2	05/93	4,4'-DDT	2	C
MW5-2	05/90	4,4'-DDT	0.78	
MW5-3	05/90	4,4'-DDT	0.16	
MW5-1	05/93	Aldrin	2.8	
MW5-1	05/90	Alpha-BHC	14	*
S2MW-2	05/93	Alpha-BHC	0.16	C
MW5-1	05/90	Beta-BHC	5	*
MW5-2	05/90	Beta-BHC	2.4	
S2MW-2	05/93	Beta-BHC	1.3	C
MW5-2	05/93	Beta-BHC	0.59	C
MW5-3	05/93	Beta-BHC	0.14	C
MW5-3	05/90	Beta-BHC	0.054	
MW5-1	05/90	Delta-BHC	13	*
MW5-1	05/93	Delta-BHC	1.74	DJX
S2MW-2	05/93	Delta-BHC	0.5	C
MW5-2	05/93	Delta-BHC	0.2	C
MW5-2	05/90	Delta-BHC	0.12	
S2MW-5	1/28/96	Endosulfan I	0.04	J
SEMIVOLATILE ORGANIC COMPOUNDS (μg/L)				
MW5-1	05/90	1,2,4-trichlorobenzene	15.5	
MW5-1	05/93	1,2,4-trichlorobenzene	4	J
S2MW-2	05/93	1,2-dichlorobenzene	3.6	
MW5-1	05/93	1,2-dichlorobenzene	3	J
MW5-1	05/93	1,2-dichlorobenzene	3	J
MW5-2	05/93	1,2-dichlorobenzene	2.8	
MW5-2	05/93	1,3-dichlorobenzene	8.2	
MW5-1	05/93	1,3-dichlorobenzene	7.25	
S2MW-2	05/93	1,3-dichlorobenzene	6.6	
MW5-1	05/90	1,3-dichlorobenzene	6	J
S2MW-2	05/93	1,3-dichlorobenzene	3.6	
MW5-2	05/90	1,3-dichlorolbenzene	2	J
S2MW-2	05/93	1,4-dichlorobenzene	37	D
MW5-2	05/93	1,4-dichlorobenzene	9.2	
MW5-1	05/93	1,4-dichlorobenzene	8.5	J
MW5-1	05/90	1,4-dichlorobenzene	7	J
MW5-1	05/90	2-methylnaphthalene	53	
MW5-2	05/90	4-methylphenol	2	J
MW5-1	05/90	Benzoic acid	4	J
MW5-1	05/93	Benzyl alcohol	7.75	
MW5-1	05/93	Bis(2-ethylhexyl)phthalate	3	J
MW5-1	05/90	Bis(2-ethylhexyl)phthalate	2	J
MW5-1	05/90	Naphthalene	43	
VOLATILE ORGANIC COMPOUNDS (μg/L)				
MW5-1	05/90	1,1-dichloroethene	64.5	J
MW5-1	05/93	1,1-dichloroethene	2.25	
MW5-1	05/90	1,2-dichloroethene (total)	1,650	D
MW5-1	05/93	1,2-dichloroethene (total)	3.5	J
MW5-1	05/90	Acetone	93	J
MW5-2	05/90	Acetone	10	B
MW5-1	05/90	Benzene	107.5	
MW5-1	05/93	Benzene	56	
MW5-1	05/90	Carbon disulfide	60	BJ
MW5-1	05/93	Carbon disulfide	5	J
MW5-2	05/90	Carbon disulfide	2	J
MW5-3	05/90	Carbon disulfide	2	J

TABLE 4-39

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 2
NAS KEY WEST
PAGE 4 OF 4

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
MW5-1	05/90	Chlorobenzene	167.6	E
MW5-1	05/93	Chlorobenzene	125	
S2MW-2	05/93	Chlorobenzene	86	D
MW5-2	05/93	Chlorobenzene	59	D
MW5-2	05/90	Chlorobenzene	57	
MW5-3	05/93	Chlorobenzene	3.7	
MW5-1	05/93	Cis-1,2-dichloroethene	840	D
MW5-1	05/90	Ethylbenzene	81.5	
MW5-1	05/93	Ethylbenzene	18.5	
MW5-2	05/93	Ethylbenzene	2.8	
MW5-1	05/90	Methylene chloride	61	BJ
MW5-1	05/93	Methylene chloride	24.3	
MW5-1	05/93	Methylene chloride	1	JB
MW5-1	05/93	Toluene	70.5	J
MW5-1	05/90	Toluene	4	
MW5-1	05/90	Trichlorethene	64	J
MW5-1	05/93	Vinyl chloride	3.6	J
MW5-1	05/90	Xylenes (total)	73.5	J
MW5-1	05/93	Xylenes (total)	16.5	J
MW5-2	05/90	Xylenes (total)	2	J

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-6).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

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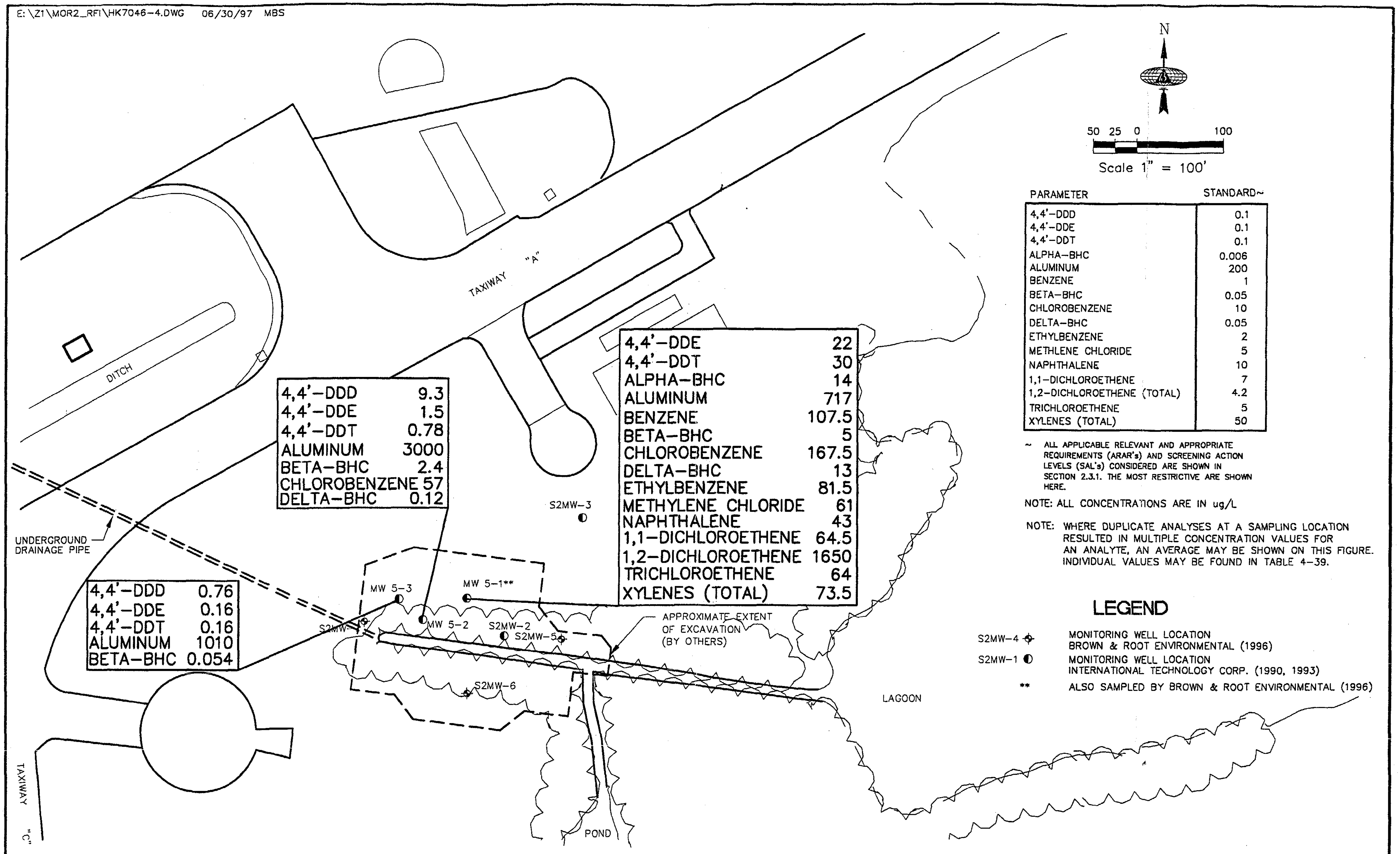


PARAMETER	STANDARD~
4,4'-DDD	0.1
4,4'-DDE	0.1
4,4'-DDT	0.1
ALPHA-BHC	0.006
ALUMINUM	200
BENZENE	1
BETA-BHC	0.05
CHLOROBENZENE	10
DELTA-BHC	0.05
ETHYLBENZENE	2
METHLENE CHLORIDE	5
NAPHTHALENE	10
1,1-DICHLOROETHENE	7
1,2-DICHLOROETHENE (TOTAL)	4.2
TRICHLOROETHENE	5
XYLENES (TOTAL)	50

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-39.

LEGEND

S2MW-4 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

S2MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)

** — ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)

SITE MANAGER: KW	CHECKED BY: -
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-21
1990 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

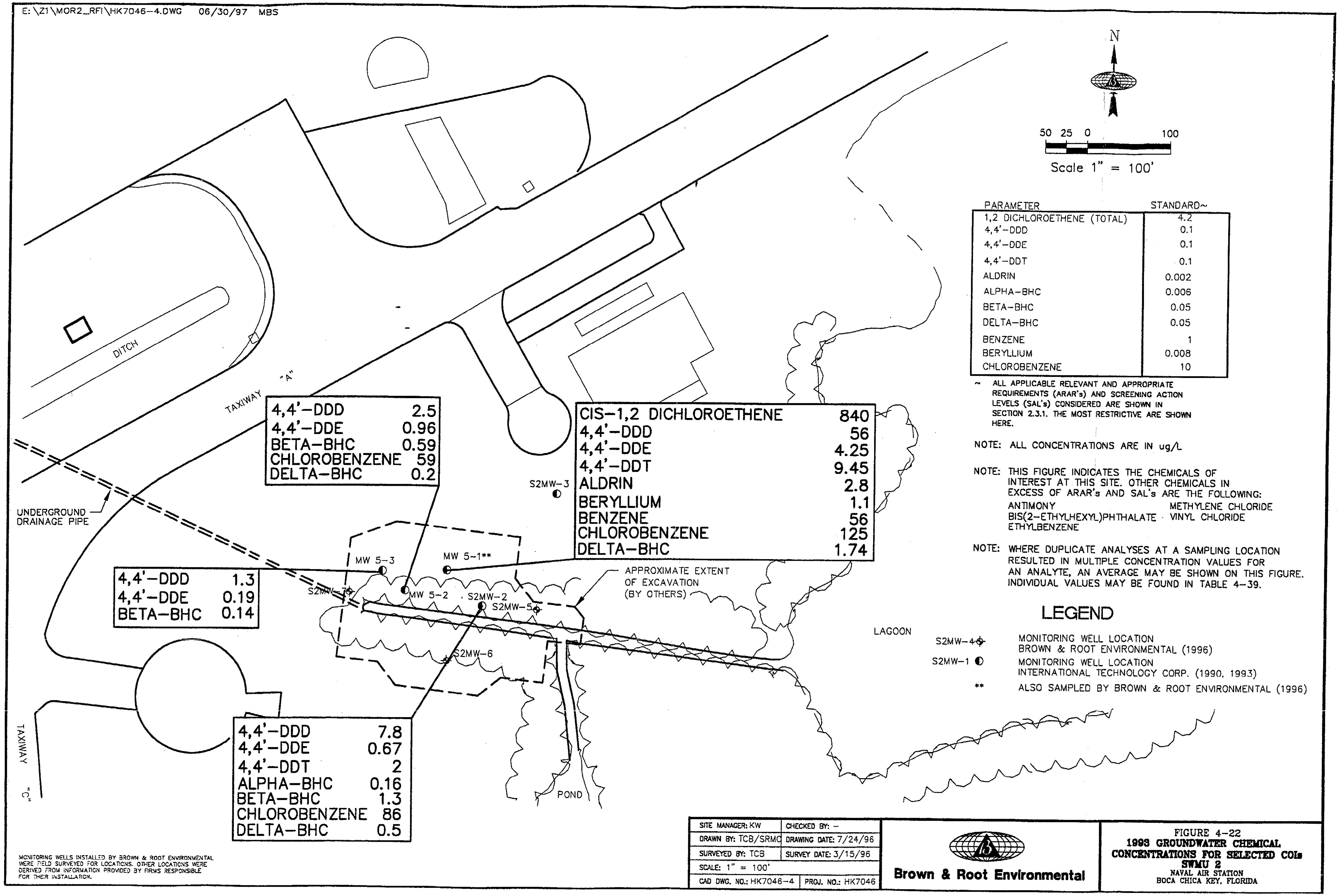
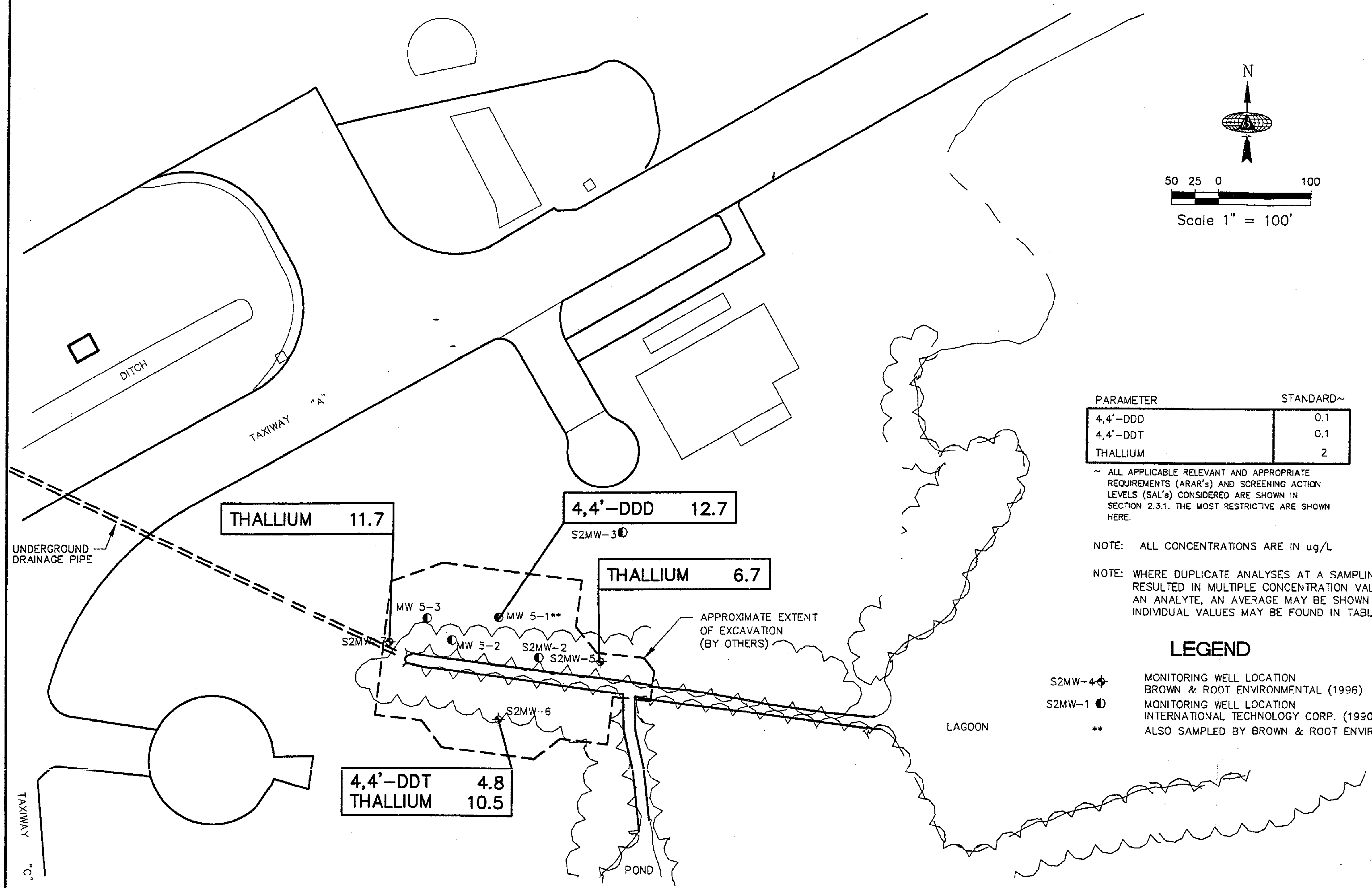


FIGURE 4-22
1993 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

E:\Z1\MOR2_RFI\HK7046-4.DWG 06/30/97 MBS



PARAMETER	STANDARD~
4,4'-DDD	0.1
4,4'-DDT	0.1
THALLIUM	2

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-39.

LEGEND

S2MW-4 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

S2MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990, 1993)

** — ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 3/15/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-4	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-23
1996 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 2
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.2.5.4.1 Volatile Organic Compounds

The VOCs 1,1-DCE, 1,2-DCE (total), benzene, CIS-1,2-DCE, chlorobenzene, ethylbenzene, methylene chloride, trichloroethene, vinyl chloride, and xylenes (total), exceeded their respective ARAR/SAL limits in groundwater under the 4,4'-DDT Mixing Area, and were found predominantly in samples from MW 5-1. Chlorobenzene and ethylbenzene were the only VOCs found outside MW 5-1 in significant quantities; although the maximum concentrations of both compounds occurred at MW5-1. In the Preliminary RI, 1,1-DCE, (64.5 µg/L), 1,2-DCE (total) (1,650 µg/L), benzene (107.5 µg/L), chlorobenzene (167.5 µg/L), ethylbenzene (81.5 µg/L), methylene chloride (61 µg/L), trichloroethene (64 µg/L), and xylenes (total) (73.5 µg/L) were detected in excess of ARAR/SAL criteria in the sample drawn from MW5-1. During the RFI/RI, benzene (56 µg/L), chlorobenzene (12.5 µg/L), CIS-1,2-DCE (840 µg/L), ethylbenzene (18.5 µg/L), methylene chloride (24.3 µg/L), and vinyl chloride (3.5 µg/L) were also found in the sample drawn from MW 5-1 during the RFI/RI.

4.2.5.4.2 Semivolatile Organic Compounds

Naphthalene and bis(2-ethylhexyl)phthalate were the only SVOCs detected in excess of the most restrictive ARAR/SAL level in groundwater at SWMU 2. At 43 µg/L, naphthalene was identified during the Preliminary RI in MW 5-1, the same location where several VOCs were detected. It was not detected during the RFI/RI. At 3 µg/L, bis(2-ethylhexyl)phthalate was identified during the RFI/RI at MW5-1. This compound was previously detected at a lower level during the Preliminary RI. The compounds 1,2,4-trichlorobenzene, 1,2-dichlorobenzene (DCB), 1,3-DCB, 1,4 -DCB, 2-methylnaphthalene, benzoic acid, 4-methylphenol, and benzyl alcohol were also detected at the site. None exceeded the applicable ARAR/SAL limits.

4.2.5.4.3 Pesticides

Over the 6-year sampling period from the Preliminary RI to the Supplemental RFI/RI, a number of pesticides were found in the groundwater under the 4,4'-DDT Mixing Area. These pesticides include 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, aldrin, alpha-BHC, beta-BHC, delta-BHC, and endosulfan I. With the exception of aldrin and endosulfan I, these compounds were detected in wells throughout the later excavated area during the Preliminary RI and the RFI/RI. Aldrin (2.8 µg/L) was detected only in MW 5-1 during the RFI/RI, while endosulfan I was only detected during the Supplemental RFI/RI in a sample from S2MW-5. The highest pesticide concentrations were generally found in samples drawn from MW 5-1. During the Supplemental RFI/RI, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and endosulfan I were the only pesticides detected in groundwater. 4,4'-DDD was detected in MW 5-1, but the level was only 12.7 µg/L, down from

56 µg/L in the RFI/RI. 4,4'-DDT was detected in a sample from S2MW-6, south of the main ditch, at a concentration of 4.8 µg/L. Groundwater had never been tested in this location, but it was the only detection of 4,4'-DDT encountered during the Supplemental RFI/RI at SWMU 2, and it was less than the maximum levels of that compound found in previous investigations at MW5-1. 4,4'-DDE was detected in S2MW-5, but the concentration was below the proposed RCRA Action Level of 0.1 µg/L, and was also less than the previously detected concentrations of 4,4'-DDE in groundwater at SWMU 2. No BHC isomers were detected during the Supplemental RFI/RI, although concentrations were in excess of ARAR/SAL criteria during earlier investigations at the site.

4.2.5.4.4 PCBs

No PCBs were detected in the groundwater at SMWU 2.

4.2.5.4.5 Metals and Inorganics

Few inorganic contaminants exceeded the most conservative ARAR/SAL criteria in groundwater at SWMU 2. Aluminum, detected in three wells, had its highest concentration (3,000 µg/L) in MW 5-2 during the Preliminary RI. Aluminum was not detected during the RFI/RI, but antimony and beryllium both exceeded their most restrictive ARAR/SAL limits during the RFI/RI. Neither compound was detected during any other investigation. Beryllium was detected at 1.1 µg/L in MW 5-1, while antimony was found in all five wells that were sampled in 1993. The maximum value of antimony was 88 µg/L in S2MW-2. During the Supplemental RFI/RI, neither antimony nor beryllium were detected but thallium was found in groundwater at a maximum level of 11.7 µg/L, which exceeds the 2-µg/L SDWA MCL. Arsenic, barium, chromium, cyanide, lead, manganese, mercury, tin, and zinc were all detected in groundwater on the site at one time or another, but none approached ARAR/SAL limits.

4.2.5.5 Summary of Contaminant Release

The pesticides 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE are present in all media at SWMU 2. This is not surprising because the site was used as a 4,4'-DDT mixing area for nearly 30 years. Metals were the next most prevalent class of compounds, being detected above the limits set by ARARs and SALs in soil, sediment, surface water, and groundwater. However, the occurrence of specific metals did not appear to be widespread, no obvious trends were evident, and there is no apparent source of metal or inorganic contamination based on the previous use of the site. Pesticides other than 4,4'-DDT appear to have been used on the site based on groundwater, soil, and sediment analyses. Several VOCs and SVOCs were detected on the site in various media, but occurred to any significant degree only in groundwater samples from a single well.

Pesticide contamination at the 4,4'-DDT Mixing Area significantly declined between 1990 and 1996. Previous investigations detected high levels of 4,4'-DDT, 4,4'-DDD, and 4,4'-DDE, as well as limited amounts of various metals, VOCS, and other pesticides. Groundwater samples drawn in 1996 show only two occurrences of 4,4'-DDD and 4,4'-DDT above the ARAR/SAL criteria for those chemicals in groundwater. In both cases, levels were reduced from the maximum concentrations seen in previous investigations. Aside from 4,4'-DDT and 4,4'-DDD, thallium (a metal that had not been detected previously on the site) also exceeded ARAR/SAL criteria in several 1996 groundwater samples. VOCs and SVOCs were not analyzed during the Supplemental RFI/RI field investigation.

Pesticides and metals were the only compounds that exceeded ARAR/SAL criteria in soil at SWMU 2. The pesticide 4,4'-DDE exceeded the most conservative ARARs or SALs with the greatest frequency, which indicates that 4,4'-DDT has been in the soil and undergoing biotransformation for some time. The maximum 4,4'-DDE concentration was 0.82 mg/kg. The next most prevalent pesticide was 4,4'-DDT, followed by 4,4'-DDD. These compounds were found around the perimeter of the excavation, and there are no obvious trends in contaminant levels. In most cases, concentrations were comparable from sample to sample. Several subsurface samples were obtained during the RFI/RI. Although 4,4'-DDT exceeded its 0.1-mg/kg ARAR/SAL level in two samples, pesticide contamination is limited predominantly to surface soil. Metals, including aluminum, arsenic, beryllium, and chromium, exceeded their associated ARAR/SAL levels in several soil samples from throughout the site; however, there did not appear to be any obvious focal point for the contamination. Most metals were either not detected or present in lower concentrations in the subsurface soil borings. Chromium contamination in subsurface samples was comparable to that seen at the surface. Subsurface cyanide detections exceeded the single surface observation of that chemical.

Pesticides were also the dominant sediment contaminant, with 4,4'-DDT and its degradation products detected at some level in each sample analyzed. The highest concentrations were found in 1996 samples from the excavated area. Although this area underwent remediation in the Spring of 1996, it was also considered the most contaminated part of the site based on delineation sampling. The western end of the main ditch (E11) displayed the maximum concentrations of all three 4,4'-DDT compounds: 4,4'-DDD (13.9 mg/kg), 4,4'-DDE (4.63 mg/kg), and 4,4'-DDT (12.55 mg/kg). The eastern side of the excavated area (M11) had much lower concentrations. Sediments outside the excavation area (M10) were sampled both before and after excavation and appeared to have reduced 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT concentrations following the remedial activity. Other pesticides, including dieldrin, endosulfan I, endrin, and delta-BHC, were detected in 1996 in the vicinity of the excavation exceeding the levels specified by ARARs and SALs. Some metal contamination was found in sediment, but generally appeared to be isolated. Arsenic and lead were both found in several samples. Arsenic was detected in two samples from the mouth of the ditch, but the highest concentration (1.5 mg/kg) was found in the northwestern part of the site adjacent to the taxiway. The maximum lead contamination (53.8 mg/kg) was found midway between the western end of the main ditch and the lagoon. Small amounts of VOCs and SVOCs were detected in sediment, but only a single compound was in excess of ARAR/SAL levels; bis(2-ethylhexyl)phthalate was in a single RFI/RI sample from the mouth of the ditch at a concentration of 2.5 mg/kg, and was not detected in later samples from the same area.

Consistent with the other media at the site, pesticides and metals were the dominant surface-water contaminants. Several compounds in each class were detected at levels that exceeded ARARs and SALs, but the surface-water contamination appears isolated, because most compounds were found only in a single sample. The only compound detected in excess of ARAR/SAL criteria in more than one sample was 4,4'-DDD. The highest concentration (1.45 µg/L) was observed in a BEI delineation sample from the later excavated area. Other pesticides detected in surface water include 4,4'-DDT, beta-BHC, and heptachlor. Aluminum, antimony, beryllium, lead, mercury, and tin were the potentially significant metal contaminants in surface water.

4.2.6 <u>Contaminant Fate and Transport</u>

The behavior of contaminants in the environment at SWMU 2 is described in this section. Various chemicals detected and their transport potential in the environment are discussed in Section 4.2.6.1. Persistence of detected chemicals in the environment is discussed in Section 4.2.6.2. Section 4.2.6.3 discusses contaminant trends. Chemical and physical properties of COPCs detected at SWMU 2 are presented in Appendix G.

4.2.6.1 Detected Chemicals and Transport Potential

Analytical results for SWMU 2 revealed that halogenated and aromatic volatiles, two PAHs (naphthalene, and 2-methylnaphthalene), 4,4'-DDT degradation products, and other pesticides were present in groundwater. Pesticides, phthalates, xylene, and halogenated volatiles were detected in surface and subsurface soils. Pesticides, acetone, 2-butanone, and phthalates were detected in sediment samples. Pesticides and acetone were detected in surface-water samples. Inorganics were detected in groundwater, soils, and surface-water samples above background levels. Inorganics detected in sediment samples were generally within background levels except for zinc, mercury, iron, cobalt, copper, cadmium, and antimony.

After the recent interim remedial action, 4,4'-DDT and its degradation products were detected at levels ranging up to the tens of ppm in several surface soil and sediment samples collected at SWMU 2. 4,4'-DDT and other pesticides (aldrin, BHCs, and endosulfan I) were detected at low levels in groundwater. The other pesticides detected in groundwater were not found at significant levels in soil or sediment. Due to their high soil/water partition coefficients, most pesticides, including 4,4'-DDT, strongly adsorb onto soil and sediment and exhibit low groundwater mobility relative to VOCs.

Other groundwater contaminants that may be related to previous site activities, include naphthalenes and chlorinated benzenes, which may represent solvents used in pesticide formulations or applications. Naphthalene and related PAHs typically exhibit moderate but lower solubilities than VOCs.

Relatively high levels of chlorinated ethenes (1,1-DCE, 1,2-DCE, and vinyl chloride) were detected in a single monitoring well and may be associated with degradation of tetrachloroethene and trichloroethene in groundwater (Cline and Vista, 1983). Chlorinated benzenes were detected in three wells at levels in the tens- to 100-ppb levels in other nearby wells. Low-ppb levels of aromatic volatiles were also detected in monitoring wells during one sampling round. The solubility and volatility of the detected VOCs make them characteristically mobile in the environment. Mono-, di-, and tri-chlorobenzenes are low molecular weight SVOCs that are considered soluble and mobile in groundwater.

The transport of lead in the aquatic environment is influenced by the speciation of the ion. Sorption processes appear to exert a dominant effect on the distribution of lead in the environment. Adsorption to inorganic solids, organic materials, and hydrous iron and manganese oxides usually controls the mobility of lead and results in its strong partitioning of lead to the bed sediments in aquatic systems. The sorption mechanism most important in a particular system varies with geological setting, pH, Eh, availability of ligands, dissolved and particulate concentrations, and chemical composition. Lead is strongly complexed to organic materials present in aquatic systems and soil (Clement Associates, 1985).

Inorganic compounds have a strong tendency to adsorb onto soil and sediment particles, a factor that greatly reduces their mobility. Many metals are water-insoluble; however, some soluble species of metals have increased mobility.

4.2.6.2 Persistence

For the classes of detected chemicals, environmental persistence varies considerably. Transformation of a chemical to degradation byproducts can be the result of numerous processes including biotransformation and uptake, photolysis, acid- or base-catalyzed reaction, or hydrolysis. The product chemicals may or may not be significantly different from a toxicological or a physical transport perspective. If the transformational process is known or suspected, product chemicals can be predicted and the extent of transformation can be determined from chemical reaction rate data. Other transformational processes can be identified empirically from analytical data.

Although most chemicals are resistant to chemical change because of their stability or lack of reaction sites, many of the more mobile species are subjected to at least limited transformation. Because of more frequent contact with reactive dissolved species and catalysts when compared to unsaturated conditions, the contaminants found in saturated media (groundwater and saturated zone soils) are most likely to be transformed in the environment. Higher molecular-weight contaminants tend to be less mobile and less prone to chemical transformation.

The compounds 1,2-DCE, 1,1-DCE, and vinyl chloride, which are byproducts of the degradation of TCE and PCE, can further degrade to lesser-chlorinated species. In addition, the low persistence of these compounds in soil is influenced by their solubility and high volatility.

4,4'-DDT degrades in soil and groundwater to the byproducts 4,4'-DDE and 4,4'-DDD, which in turn may persist for a considerable time before being further degraded in the environment. The ultimate fate process for 4,4'-DDT generally occurs very slowly and involves biotransformation to form bis(2-chlorophenyl)methanone (Clement Associates, 1985). Half-lives for the decomposition of 4,4'-DDT in aerobic soils have been reported in the range of 10 to 14 years (Neely, 1985). In flooded soils, an anaerobic environment contributes to the reductive dehalogenation of 4,4'-DDT.

4.2.6.3 Observed Chemical Contaminant Trends

Although several monitoring wells are in close proximity of one another at SWMU 2, no lateral migration of chlorinated ethenes beyond the one contaminated well has been observed. Since the detected levels were consistently close to 1 ppm, lateral contaminant migration may, to some extent, become discernible in the future. In contrast, dichlorinated benzenes were detected in the tens of ppb in several wells and trichlorobenzene was detected in two wells. The more widespread distribution of chlorinated benzenes in groundwater suggests that these compounds may have been present in the 4,4'-DDT formulations that produced soil contamination throughout SWMU 2. Other SWMU 2 media (surface water, soil, and sediment) revealed only trace ppb levels of VOCs, which suggests that source areas in soil have since been depleted or were mitigated by the recent interim removal action.

As discussed in Section 4.2.5, all sampled media (groundwater, surface water, sediment, subsurface soil, and surface soil) revealed impacts of 4,4'-DDT contaminant migration associated with surface water runoff, soil erosion, and groundwater movement. 4,4'-DDT and related compounds were observed in groundwater only in the immediate vicinity of the former 4,4'-DDT mixing area and not in wells at further distances from the source area. Although a recent 4,4'-DDT removal action has substantially reduced sediment levels within the ditch that leads through the site, concentrations near the mouth of the lagoon and in the excavation area are still greater than background. Continued transport of contaminated sediment through erosional dispersion towards the lagoon is possible, although the magnitude of potential impacts would be much less significant now that the majority of the contaminant source has been removed.

Endosulfan I, BHCs, and endrin were each detected in groundwater, soils, and sediments, which indicates that these pesticide compounds are also associated with impacts of past site activities. However, soil concentrations of these additional pesticides were relatively low and not widespread, which suggests that there is little, if any, potential for further measurable impacts caused by migration of these substances.

Although several metals were detected at levels greater than background in each sampled media, the occurrence and frequency of low-level metals contamination was different in each medium. Therefore, no obvious pattern of contaminant migration is suggested for most metals.

Antimony, however, was detected at elevated levels (tens of ppb) in site-related groundwater samples collected during an earlier investigation but was not found at relatively low detection limits in the most recent round of sampling. Since antimony is not normally found in seawater at levels near this concentration range, this suggests that earlier antimony data may not be as trustworthy as recent results, conceivably because of analysis interferences or sensitivity problems associated with earlier sampling rounds.

Several organic substances were detected that are considered common or ubiquitous laboratory contaminants. Despite the use of proper sampling protocols and data validation to minimize analytical bias, methylene chloride, acetone, and bis(2-ethylhexyl)phthalate remained after data validation in both site and background data sets, which does not suggest any pattern of contamination related to SWMU 2 activities for these substances.

4.2.7 Baseline Human Health Risk Assessment

This section presents the baseline human health risk assessment for SWMU 2. It includes a discussion of the preliminary risk evaluation, data evaluation, toxicity assessment, exposure assessment, risk characterization, and remedial option goals. Conclusions about the baseline human health risk assessment are presented in Section 4.2.7.8. The baseline HHRA presented in this section is a qualitative and quantitative assessment of actual or potential risks for SWMU 2. The methodologies and techniques used in the assessment are outlined in Section 3.2 of Appendix G.

4.2.7.1 Preliminary Risk Evaluation

Tables 4-40 and 4-41 summarize the preliminary risk evaluations for SWMU 2 for carcinogenic and noncarcinogenic risks, respectively. The risk ratio calculated assuming an industrial land use scenario is less than 1E-04 and 1.0 for carcinogenic and noncarcinogenic effects. The calculated risk ratio assuming a residential land use scenario is equal to 1E-04 for carcinogenic effects (Table 4-40). The risk ratio calculated assuming a residential land use scenario is greater than 1.0 for noncarcinogenic effects (Table 4-41). Thus, a baseline human health risk assessment is necessary for SWMU 2. The preliminary contributors to the carcinogenic risk equaling 1E-04 are arsenic in surface soil, 4,4'-DDT, and arsenic in sediment; and arsenic, heptachlor, 4,4'-DDT, and beta-BHC in surface water. The preliminary contributors to the noncarcinogenic HI exceeding 1.0 are antimony, arsenic, selenium, and 4,4'-DDT in soils and antimony, copper, and mercury in surface water. Appendix G, Section 3.2.1 contains the methods used for preliminary risk assessment analysis. Lead will be evaluated separately using EPA's IEUBK Lead Model (v. 0.99).

4.2.7.2 Data Evaluation

A list of COPCs was developed for each environmental medium, as necessary. Only those chemicals found to be of potential concern were considered for evaluation in the quantitative risk assessment. A discussion of those chemicals identified as COPCs for each medium is provided in this section. See Appendix G, Section 3.2.2 for a discussion of data evaluation procedures.

4.2.7.2.1 <u>Soils</u>

Several VOCs, SVOCs, pesticides, and metals were detected in one or more of the soil samples collected at SWMU 2.

The occurrence and distribution of chemicals in surface soil and subsurface soil are listed in Tables 4-42 through 4-45. COPC selection results and representative concentration for chemicals detected in

TABLE 4-40

PRELIMINARY RISK EVALUATION - CARCINOGENIC EFFECTS
SWMU 2
NAS KEY WEST

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
INORGANICS											
Arsenic	2.7	1.5	ND	0.43	0.43	0.045	3.8	6E-06	4E-06	NA	7E-07
Beryllium	0.23	0.11	0.205	0.15	0.15	0.016	1.3	2E-06	7E-07	1E-05	2E-07
PESTICIDES/PCBs											
4,4'-DDD	1,160	17,200	1.45	2.7	2.7	0.28	24	4E-07	6E-06	5E-06	5E-08
4,4'-DDE	316	4,640	ND	1.9	1.9	0.2	17	2E-07	2E-06	NA	2E-08
4,4'-DDT	4,400	14,800	0.33	1.9	1.9	0.2	17	2E-06	8E-06	2E-06	3E-07
Aldrin	1	ND	0.11	0.038	0.038	0.004	0.34	3E-08	NA	2E-05	3E-09
Alpha-BHC	1	ND	ND	0.1	0.1	0.011	0.91	1E-08	NA	NA	1E-09
Beta-BHC	2	ND	0.15	0.35	0.35	0.037	3.2	6E-09	NA	4E-06	6E-10
Gamma-BHC	1	ND	ND	0.49	0.49	0.052	4.4	2E-09	NA	NA	2E-10
Heptachlor	ND	ND	0.064	0.14	0.14	0.0023	1.3	NA	NA	3E-05	NA
Heptachlor epoxide	16	ND	ND	0.07	0.07	0.0012	0.63	2E-07	NA	NA	3E-08
Toxaphene	343	ND	ND	0.58	0.58	0.061	5.2	6E-07	NA	NA	7E-08
SEMIVOLATILE ORGANIC COMPOUNDS											
Bis(2-ethylhexyl)phthalate	310	2,500	ND	46	46	4.8	410	7E-09	5E-08	NA	8E-10
VOLATILE ORGANIC COMPOUNDS											
1,1,1,2-tetrachloroethane	1	ND	ND	25	25	0.41	220	4E-11	NA	NA	5E-12
1,2,3-trichloropropane	2	ND	ND	0.091	0.091	0.0015	0.82	2E-08	NA	NA	2E-09
Methylene chloride	27	53	1	85	85	4.1	760	3E-10	6E-10	2e-07	4E-11
							Risk Sums by Medium	**1E-05**	**2E-05**	**7E-05**	**1E-06**
							Risk Sums by Use Scenario		**1E-04**		**1E-06**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCBs concentrations are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
NA = Not applicable.

TABLE 4-41

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 2
NAS KEY WEST
PAGE 1 OF 2

	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
Chemical*	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
INORGANICS											
Aluminum	6,140	928	1,510	78,000	78,000	37,000	1,000,000	8E-02	1.E-02	4E-02	6E-03
Antimony	4.7	0.44	13	31	31	15	820	2E-01	1E-02	9E-01	6E-03
Arsenic	2.7	1.5	ND	23	23	11	610	1E-01	7E-02	NA	4E-03
Barium	14.9	8.7	16.3	5,500	5,500	2,600	140,000	3E-03	2E-03	6E-03	1E-04
Beryllium	0.23	0.11	0.205	390	390	180	1,000	6E-04	3E-04	1E-03	2E-04
Cadmium	0.84	1.9	ND	39	39	18	1,000	2E-02	4E-02	NA	8E-04
Chromium VI	11.6	8.1	ND	390	390	180	10,000	3E-02	2E-02	NA	1E-03
Cobalt	0.55	0.087	ND	4,700	4,700	2,200	120,000	1E-04	1E-05	NA	5E-06
Copper	7.6	18.6	272	3,100	3,100	1,500	82,000	3E-03	6E-03	2E-01	9E-05
Cyanide	25	ND	ND	1,600	1,600	730	41,000	2E-02	NA	NA	6E-04
Iron	1,960	2,630	236	23,000	23,000	11,000	610,000	9E-02	1E-01	2E-02	3E-03
Manganese	20.1	14	4.05	390	390	180	10,000	5E-02	4E-02	2E-02	2E-03
Mercury	0.055	0.05	0.0675	23	23	11	610	2E-03	2E-03	6E-03	9E-05
Nickel	3.2	3.3	ND	1,600	1,600	730	41,000	2E-03	2E-03	NA	8E-05
Selenium	618	0.56	ND	390	390	180	10,000	2E+00	1E-03	NA	6E-02
Silver	0.15	ND	ND	390	390	180	10,000	3E-04	NA	NA	2E-05
Tin	6.2	1.8	10	47,000	47,000	22,000	1.00E+06	1E-04	4E-05	5E-04	6E-06
Vanadium	7	4.5	1.65	550	550	260	14,000	1E-02	8E-03	6E-03	5E-04
Zinc	23.3	170	36.6	23,000	23,000	11,000	610,000	1E-03	7E-03	3E-03	4E-05
PESTICIDES/PCBs											
4,4'-DDT	4,400	14,800	0.33	39	39	18	1,000	1E-01	4E-01	2E-02	4E-03
Aldrin	1	ND	ND	2.3	2.3	1.1	61	4E-04	NA	NA	2E-05
Endosulfan I	2	359	ND	470	470	220	12,000	4E-06	8E-04	NA	2E-07
Endosulfan II	7	ND	ND	470	470	220	12,000	2E-05	NA	NA	6E-07
Endrin	7	244	ND	23	23	11	610	3E-04	1E-02	NA	1E-05
Gamma-BHC	1	ND	ND	39	39	180	610	3E-05	NA	NA	2E-06
Heptachlor	ND	ND	0.062	39	39	18	1,000	NA	NA	3E-03	NA
Heptachlor epoxide	16	ND	ND	1	1	0.47	27	2E-02	NA	NA	6E-04
Methoxychlor	9	ND	ND	390	390	180	10,000	2E-05	NA	NA	9E-07
SEMIVOLATILE ORGANIC COMPOUNDS											
Benzyl alcohol	ND	ND	5	23,000	23,000	11,000	610,000	NA	NA	5e-04	NA
Bis(2-ethylhexyl)phthalate	670	2,500	ND	1,600	1,600	730	41,000	4E-04	2E-03	NA	2E-05

TABLE 4-41

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 2
NAS KEY WEST
PAGE 2 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
VOLATILE ORGANIC COMPOUNDS											
1,1,1,2-tetrachloroethane	1	ND	ND	2,300	2,300	1,100	61,000	4E-07	NA	NA	2E-08
1,2,3-trichloropropane	2	ND	ND	390	390	180	10,000	5E-06	NA	NA	2E-07
2-butanone	23	10	ND	47,000	47,000	1,900	1,000,000	5E-07	2E-07	NA	2E-08
Acetone	81	51	13	7,800	7,800	3,700	200,000	1E-05	7E-06	4E-03	4E-07
Carbon disulfide	ND	10	ND	7,800	7,800	1,000	200,000	NA	1E-06	NA	NA
Cis-1,2-dichloroethene	10	ND	ND	780	780	61	20,000	1E-05	NA	NA	5E-07
Methacrylonitrile	160	ND	ND	7.8	7.8	200	3.7	2E-02	NA	NA	4E-02
Methylene chloride	27	53	1	4,700	4,700	2,200	120,000	6E-06	1E-05	2E-04	2E-07
Hazard Sums by Medium								**3E+00**	**7E-01**	**1E+00**	**1E-01**
Hazard Sums by Use Scenario									**5E+00**		**1E-01**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCBs concentrations are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
NA = Not applicable.

TABLE 4-42

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE SOIL - SWMU 2 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	11/11	120-4,250	2,130	4/4	452-6,140	2,830	7,800	6,140	N	A
Antimony	2/12	0.26-0.48	0.428	4/7	0.25-4.7	1.26	3.1	4.70	Y	C
Arsenic	6/12	0.63-2.7	1.4	7/7	0.54-2.7	1.59	0.43	2.70	N	G
Barium	12/12	4.4-17.7	11	7/7	7.1-14.9	9.39	550	11.89	N	A
Beryllium	2/12	0.13-0.15	0.054	6/7	0.092-0.23	0.14	0.15	0.23	Y	C
Cadmium	4/12	0.11-0.45	0.173	5/7	0.12-0.84	0.38	3.9	0.84	N	A
Calcium	11/11	265,000-449,000	362,000	4/4	318,000-378,000	346,625	–	378,000	N	D
Chromium	12/12	1.9-15.5	6.22	7/7	2.9-11.6	6.67	7,800	11.60	N	A
Cobalt	7/12	0.22-0.51	0.341	4/7	0.18-0.55	0.64	470	0.55	N	A
Copper	11/12	1.3-15.6	5.28	6/7	1.2-7.6	3.54	310	7.60	N	A
Cyanide	0/5	Not Detected	–	1/2	18-18	12.25	160,000	18	N	A
Iron	11/11	98.1-2,260	1,290	4/4	659-1,960	1,274	2,300	1,960	N	A
Lead	11/12	0.65-48.3	16.8	16/17	0.27-55.4	15.59	–	55.40	Y	H
Magnesium	11/11	1,340-24,600	7,800	4/4	3,380-7,230	5,729	–	7,230	N	D
Manganese	11/11	2.6-33.7	19.4	4/4	8.6-20.1	14.34	39	20.10	N	A
Mercury	2/12	0.048-0.08	0.033	1/7	0.055-0.055	0.02	2.3	0.04	N	A
Nickel	8/12	0.63-4.1	1.63	4/7	0.78-3.2	1.41	160	2.16	N	A
Potassium	11/11	48.6-944	356	4/4	125-896	488.25	–	896	N	D
Selenium	4/12	0.46-1.8	0.724	4/7	0.33-1.2	.479	39	1.2	N	A
Silver	0/5	Not detected	–	1/7	0.15	0.18	39	0.15	N	A
Sodium	11/11	834-18,700	4,620	4/4	1,180-6,100	3,014	–	6,100	N	D
Tin	2/5	0.78-2.1	1.94	5/7	0.71-6.2	2.11	4,700	4.73	N	A
Vanadium	12/12	0.8-8.8	3.71	6/7	1.7-7	3.09	55	7	N	A
Zinc	12/12	0.63-89.1	19	7/7	1.8-23.3	7.86	2,300	23.30	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max <2XBKGDAVE.

TABLE 4-43

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE SOIL - SWMU 2 (µg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	1/8	6.7	5.71	26/36	3.9-316	433	2,700	316	Y	E
4,4'-DDE	3/8	3.9-53.3	12.38	33/36	7-1,160	221	1,900	544	Y	E
4,4'-DDT	4/8	2.6-9.3	7.62	32/36	4.95-4,400	246	1,900	376	Y	B
Aldrin	0/8	Not detected	—	3/36	1-1	15	38	1	N	A
Alpha-BHC	0/8	Not detected	—	2/36	1-1	15	100	1	N	A
Beta-BHC	0/8	Not detected	—	2/36	2-2	15	350	2	N	A
Delta-BHC	0/8	Not detected	—	2/36	1-1	15	–	1	Y	F
Endosulfan I	0/8	Not detected	—	5/36	1-2	16	47,000	2	N	A
Endosulfan II	0/8	Not detected	—	2/36	1-7	31	47,000	7	N	A
Endosulfan sulfate	0/8	Not detected	—	1/36	3	31.90	–	3	Y	F
Endrin	0/8	Not detected	—	5/36	2-7	29	2,300	7	N	A
Endrin ketone	0/8	Not detected	—	1/32	3	31	–	3	Y	F
Gamma-BHC	0/8	Not detected	—	1/36	1	15	490	1	N	A
Heptachlor epoxide	0/8	Not detected	—	2/36	6-16	17.55	70	16	N	A
Methoxychlor	0/8	Not detected	—	2/36	3-9	156	39,000	9	N	A
Toxaphene	0/8	Not detected	—	2/36	91-343	740	580	343	N	A
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	1/11	330	471	2/2	200-310	255	46,000	310	N	A
VOLATILE ORGANIC COMPOUNDS										
2-butanone	0/10	Not detected	—	1/6	3	6	4,700,000	3	N	A
Acetone	1/12	1-12	3.67	2/6	29-47	17	780,000	47	N	A
Cis-1,2-dichloroethene	0/4	6	—	2/9	6-8	3	78,000	8	N	A
Methylene chloride	6/12	0.11-14	2.80	2/9	24-27	10	85,000	25	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E=06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC, Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max < 2XBKGDAVE, inorganics only.
H = COPC, Evaluated using IEUBK lead model, Max <2XBKGDAVE.

TABLE 4-44

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SUBSURFACE SOIL - SWMU 2 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Arsenic	6/12	0.63-2.7	1.4	1/3	0.22	0.24	3.8	0.22	N	A
Barium	12/12	4.4-17.7	11	3/3	3.5-5.4	4.50	14,000	5.40	N	A
Beryllium	2/12	0.13-0.15	0.054	2/3	0.14-0.15	0.12	1.3	0.15	N	A
Chromium	12/12	1.9-15.5	6.22	3/3	2.8-3.3	2.97	100,000	3.30	N	A
Cyanide	0/5	Not detected	–	2/2	21-25	23	4,100	25.00	N	A
Lead	11/12	0.65-48.3	16.8	2/3	0.56-3.6	1.52	–	3.60	N	A
Tin	2/5	0.78-2.1	1.94	1/3	4.3	2.62	100,000	4.30	N	A
Zinc	12/12	0.63-89.1	19	3/3	1.5-2.1	1.87	61,000	2.10	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

TABLE 4-45

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs ORGANICS IN SUBSURFACE SOIL - SWMU 2 (µg/kg) NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	1/8	6.7	5.7	3/8	29-32	31.94	24,000	32	N	A
4,4'-DDE	3/8	3.9-53.3	12.4	5/8	11-71	56.50	17,000	71	N	A
4,4'-DDT	4/8	2.6-9.3	7.6	6/8	10-410	162.88	17,000	410	N	A
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	1/11	330	471	2/2	160-670	415	410,000	670	N	A
VOLATILE ORGANIC COMPOUNDS										
1,1,1,2-tetrachloroethane	2/12	4-6	1.96	1/5	1	0.92	220,000	1	N	A
1,2,3-trichloropropane	0/12	Not detected	—	1/5	2	1.36	820	2	N	A
2-butanone	0/10	Not detected	—	1/2	23	14.50	100,000,000	23	N	A
Acetone	2/12	1-12	3.67	2/2	29-81	55	20,000,000	81	N	A
Cis-1,2-dichloroethene	0/4	Not detected	—	2/5	2.7-10	3.38	2,000,000	10	N	A
Methacrylonitrile	0/12	Not detected	—	1/2	160	83	20,000	160	N	A
Methylene chloride	7/12	0.11-14	2.8	2/5	12-23	12.50	760,000	21	N	A
Xylenes (total)	0/12	Not detected	—	1/5	2	1.36	100,000,000	2	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

SWMU 2 environmental media are also listed in these tables. The following chemicals were selected as COPCs for SWMU 2 surface and subsurface soils:

SURFACE SOILS		SUBSURFACE SOILS	
Inorganics	Organics	Inorganics	Organics
Antimony	4,4'-DDD	None	None
Beryllium	4,4'-DDE		
Lead*	4,4'-DDT		
	Delta-BHC**		
	Endosulfan sulfate**		
	Endrin ketone**		

Lead (*) will be evaluated using the IEUBK Lead Model (v. 0.99) for surface soils. No quantitative toxicity values for these chemicals (**) are listed; therefore, they will be evaluated qualitatively in the uncertainty section.

The metals selected as COPCs were detected in 50 percent or more of the samples analyzed. Antimony exceeded background concentrations and the RBC screening value. Uncertainty is associated with the selection of beryllium as a COPC because it may represent background concentrations, which would overestimate the risk. The nature of the uncertainty lies in the "B" qualified (i.e., analyte detected below reporting limit) beryllium data at SWMU 2. Of the six pesticides selected as COPCs, only 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT will be evaluated quantitatively. These three pesticides were detected at high frequencies (i.e., detected in 70 percent or more of the samples). 4,4'-DDT was the only pesticide that exceeded a listed residential soil RBC; however, 4,4'-DDD and 4,4'-DDE were also selected as COPCs because they are structurally similar to 4,4'-DDT. The organics without toxicity values, delta-BHC, endosulfan sulfate, and endrin ketone will be discussed in the uncertainty section. No subsurface inorganics or organics were selected as COPCs based on a comparison to RBC and background levels (inorganics only).

4.2.7.2.2 Sediment and Surface Water

VOCs, SVOCs, pesticides, and metals were detected in one or more of the sediment samples collected at SWMU 2. The occurrence and distribution of chemicals in sediment and surface water are listed in Tables 4-46 through 4-49. COPC selection results and representative concentrations for chemicals

TABLE 4-46

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SEDIMENT - SWMU 2 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	4/4	497-3,350	2,042	4/4	459-928	699	7,800	928	N	A
Antimony	0/5	Not detected	–	2/3	0.42-0.44	1.30	3.1	0.44	N	A
Arsenic	2/4	1.5-1.6	1.71	3/3	0.72-1.5	1.01	0.43	1.50	N	G
Barium	5/5	5-15.2	9.88	3/3	4.5-8.7	6.60	550	8.70	N	A
Beryllium	1/5	0.12-0.12	0.11	2/3	0.091-0.11	0.10	0.15	0.11	N	A
Cadmium	2/5	0.12-0.9	0.42	4/5	0.44-1.9	1.25	3.9	1.90	N	A
Calcium	4/4	223,000-393,000	325,250	4/4	304,000-325,000	313,000	–	325,000	N	D
Chromium	5/5	2.1-11.7	6.94	5/5	3-8.1	5.76	7,800	8.10	N	A
Cobalt	2/5	0.12-0.56	0.88	2/3	0.14-0.87	1.00	470	0.87	N	A
Copper	5/5	0.76-34.6	9.01	5/5	8-18.6	12.60	310	18.60	N	A
Iron	4/4	363-2,600	1,305	4/4	1,090-2,630	1,523	2,300	2,630	Y	C
Lead	4/5	5.5-56.5	24.65	5/5	12.8-31.7	24.34	–	31.70	N	G
Magnesium	4/4	4,680-20,000	12,425	4/4	1,530-3,100	2,158	–	3,100	N	D
Manganese	4/4	14.9-38.5	21.95	4/4	7.3-14	10.23	39	14	N	A
Mercury	0/5	Not detected	–	2/3	0.04-0.05	0.04	2.3	0.05	N	A
Nickel	4/5	0.7-5.5	2.49	2/3	1.4-3.3	2.23	160	3.30	N	A
Potassium	4/4	517-4,180	1,469	2/2	215-277	246	–	277	N	D
Selenium	1/5	0.24-0.24	1.04	2/3	0.44-0.56	0.40	39	0.56	N	A
Sodium	4/4	5,500-86,900	28,788	4/4	4,090-7,580	5,910	–	7,580	N	D
Tin	1/2	0.99-0.99	2.85	2/3	1.6-1.8	2.15	4,700	1.80	N	A
Vanadium	5/5	2.8-8.9	4.84	3/3	2.5-4.5	3.30	55	4.50	N	A
Zinc	5/5	3.5-58.2	30.40	5/5	33.3-170	68.90	2,300	170	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

TABLE 4-47

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SEDIMENT - SWMU 2 (µg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	0/2	Not detected	—	8/10	440-17,200	6,105	2,700	17,200	Y	B
4,4'-DDE	0/2	Not detected	—	8/10	170-4,640	1,864	1,900	4,640	Y	B
4,4'-DDT	0/2	Not detected	—	9/10	16-14,800	4,298	1,900	14,800	Y	B
Delta-BHC	0/2	Not detected	—	2/8	159-231	235.38	–	231	Y	F
Endosulfan I	0/2	Not detected	—	1/8	359	244.50	47,000	359	N	A
Endrin	0/2	Not detected	—	1/8	244	430.81	2,300	244	N	A
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	1/5	4,500	2,299	1/2	2,500	2,900	46,000	2,500	N	A
VOLATILE ORGANIC COMPOUNDS										
2-butanone	1/5	4	8.8	1/3	10	9.83	4,700,000	10	N	A
Acetone	3/5	4-120	34.3	3/3	11-51	29.33	780,000	51	N	A
Carbon disulfide	0/5	Not detected	—	1/3	10	6.50	780,000	10	N	A
Methylene chloride	2/5	5-20	7.6	3/5	10-53	18.70	85,000	53	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

TABLE 4-48

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE WATER - SWMU 2 (µg/L) NAS KEY WEST

Chemical	Background			Site			Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	2/5	25-148	37.9	3/3	34-1,510	529.47	3,700	1,510	N	A
Antimony	2/5	3.5-7.3	2.9	1/4	13	11.05	11.5	13	Y	C
Barium	6/6	5.8-16.3	9.05	3/3	9.8-16.3	13.9	260	16.3	N	A
Beryllium	2/7	0.17-0.26	0.27	1/3	0.205	0.4	0.016	0.205	N	G
Calcium	5/5	105,000-326,000	200,200	3/3	122,500-246,000	203,500	–	246,000	N	D
Iron	2/5	61.6-170	47.2	3/3	63.05-236	137.02	1,100	236	N	A
Lead	0/6	Not detected	–	1/4	53.6	17.86	15	53.6	Y	F
Magnesium	5/5	193,000-1,360,000	684,000	3/3	343,000-819,000	651,333	–	819,000	N	D
Manganese	2/5	3.2-12.3	3.40	1/3	4.05	2.02	84	4.05	N	A
Mercury	1/7	0.48	0.12	1/3	0.0675	0.09	1.1	0.0675	N	A
Potassium	5/5	70,600-418,000	227,000	3/3	148,500-232,000	200,167	–	232,000	N	D
Silver	0/7	Not detected	–	2/3	6.8-8.2	5.25	16	8.2	N	A
Sodium	5/5	1,720,000-11,800,000	5,980,000	3/3	3,100,000-6,590,000	5,366,667	–	6,590,000	N	D
Tin	0/4	Not detected	–	1/2	10	6.25	2,200	10	N	A
Vanadium	2/7	2-2.8	2.26	1/4	1.65	3.04	26	1.65	N	A
Zinc	4/7	1.4-21.5	6.51	3/3	2-36.6	20.33	1,100	36.6	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

TABLE 4-49

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE WATER - SWMU 2 (µg/L)
NAS KEY WEST

	Background			Site						
Chemical	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	Tap-water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
PESTICIDES/PCBs										
4,4'-DDD	0/8	Not detected	--	2/5	0.24-1.45	0.37	0.28	1.45	Y	B
4,4'-DDT	0/8	Not detected	--	1/5	0.33	0.11	0.2	0.33	Y	B
Aldrin	0/8	Not detected	--	1/5	0.11	0.04	0.004	0.11	Y	B
Beta-BHC	0/8	Not detected	--	1/5	0.15	0.05	0.037	0.15	Y	B
Heptachlor	0/8	Not detected	--	1/5	0.064	0.03	0.0023	0.0582	Y	B
SEMIVOLATILE ORGANIC COMPOUNDS										
Benzyl alchohol	0/7	Not detected	--	1/4	5	3.13	1,100	5	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	2/7	4-12	4.14	1/3	13	7.67	370	13	N	A
Methylene chloride	2/7	1-2	1.57	2/3	1	1.50	4.1	1	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max <RBC.
B = COPC, Max >RBC, organics only.
C = COPC, Max >RBC and Max >2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max >RBC but Max <2XBKGDAVE, inorganics only.

detected in SWMU 2 environmental media are also listed in these tables. The following chemicals were selected as COPCs for SWMU 2 sediment and surface water:

SEDIMENT		SURFACE WATER	
Inorganics	Organics	Inorganics	Organics
Iron	4,4'-DDD	Antimony	4,4'-DDD
	4,4'-DDE	Lead*	4,4'-DDT
	4,4'-DDT		Aldrin
	Delta-BHC*		Beta-BHC
			Heptachlor

No quantitative toxicity values for these chemicals (*) are listed, therefore, they will be evaluated qualitatively in the uncertainty section.

Iron was the only inorganic compound selected as a COPC in SWMU 2 sediments; its maximum concentration (2,630 mg/kg) slightly exceeded the residential soil RBC of 2,300 mg/kg. Iron concentrations in sediment are similar to background concentrations. Uncertainty is associated with the selection of iron as a COPC because it might represent background concentrations, which would overestimate the risk. Pesticides, including 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and delta-BHC were selected as COPCs in sediment at SWMU 2. 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected at a high frequencies (i.e., detected in 80 percent or more of the samples) with levels two to eight times greater than the residential soil RBC values. Delta-BHC does not have a quantitative toxicity value (i.e., RfD or SF), and will be discussed in the uncertainty section.

Although several metals were detected in surface water samples at SWMU 2, lead and antimony were the only metals selected as COPCs. All of the pesticides detected in surface water (4,4'-DDD, 4,4'-DDT, aldrin, beta-BHC, and heptachlor) were selected as COPCs. The RBCs for tap water ingestion were used as a point of comparison because RBCs for typical surface water exposure (i.e., recreational exposures) are not currently published by EPA. It should be noted that surface water exposure (industrial or recreational) is generally less intensive than tap water exposure (i.e., exposures resulting from the typical domestic use of a water supply). Thus, the use of the tap water RBCs to select surface water COPCs is very conservative. None of the organics detected in the surface water samples were selected as COPCs. Lead will be evaluated qualitatively in the uncertainty section.

Methods for selection of COPCs and development of representative concentrations, and other data evaluation procedures are presented in Section 3.2.2 of Appendix G.

4.2.7.3 Toxicity Assessment

The toxicological profiles for selected COPCs at SWMU 2 are presented in Appendix A. All relevant quantitative and qualitative toxicity assessment information and methods were presented in Section 3.2.3 of Appendix G.

4.2.7.4 Exposure Assessment

The COPCs were selected for each environmental media sampled at SWMU 2 are listed in Section 4.2.7.2. The potential receptors identified in Appendix G, Section 3.2.4.2, that apply to media sampled at SWMU 2 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. Consequently, with the exception of the excavation worker, all potential receptors and exposure pathways discussed in Section 3.2.4 of Appendix G were evaluated quantitatively. No COPCs were selected for subsurface soils. All exposure parameters, exposure routes, intakes, and other relevant exposure assessment information are presented in Section 3.2.4 of Appendix G. Example calculations for estimated intakes are presented in Appendix A.

4.2.7.5 Risk Characterization

This section presents the results of the quantitative risk assessments. Table 4-50 lists the estimated cumulative carcinogenic and noncarcinogenic risks for hypothetical future residents, trespasser adults and children, maintenance workers, excavation workers, and occupational workers at SWMU 2. The total risk for each exposure route and the cumulative risk across all exposure pathways are listed. The risks associated with a particular COPC are provided in the risk assessment spreadsheets in Appendix A. This section discusses the human health risk assessment in three parts:

- Carcinogenic risks
- Noncarcinogenic risks
- The results of the evaluation of lead in surface soils using the IEUBK model

Additionally, a comparison of groundwater results to screening criteria and a special note concerning fish are presented.

TABLE 4-50

CUMULATIVE RISKS
SWMU 2*
NAS KEY WEST
PAGE 1 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
Surface Soil						
Dermal Contact	3E-06	1E-07	1E-07	8E-08	NA	7E-07
Incidental Ingestion	2E-06	4E-08	4E-08	3E-08	NA	2E-07
Inhalation of Fugitive Dust	2E-08	1E-10	1E-10	1E-10	NA	3E-09
Subtotal of Media	5E-06	1E-07	1E-07	1E-07	NA	9E-07
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	**	NA
Incidental Ingestion	NA	NA	NA	NA	**	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
Sediment						
Dermal Contact	2E-05	6E-06	4E-06	NA	NA	NA
Incidental Ingestion	5E-06	5E-07	5E-07	NA	NA	NA
Subtotal of Media	3E-05	7E-06	5E-06	NA	NA	NA
Surface Water						
Dermal Contact	2E-05	4E-06	3E-06	NA	NA	NA
Incidental Ingestion	1E-06	2E-07	2E-07	NA	NA	NA
Subtotal of Media	2E-05	4E-06	3E-06	NA	NA	NA
Total	6E-05	1E-05	8E-06	1E-07	NA	9E-07
HAZARD INDEX						
Surface Soil						
Dermal Contact	3E-02	1E-03	2E-03	6E-04	NA	5E-03
Incidental Ingestion	2E-01	1E-03	3E-03	7E-04	NA	6E-03
Inhalation of Fugitive Dust	**	**	**	**	NA	**
Subtotal of Media	2E-01	2E-03	5E-03	1E-03	NA	1E-02
Subsurface Soil						
Dermal Contact	NA	NA	NA	NA	**	NA
Incidental Ingestion	NA	NA	NA	NA	**	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA

TABLE 4-50

CUMULATIVE RISKS
SWMU 2*
NAS KEY WEST
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX (cont.)						
Sediment						
Dermal Contact	2E-01	6E-02	8E-02	NA	NA	NA
Incidental Ingestion	1E-01	7E-03	1E-02	NA	NA	NA
Subtotal of Media	3E-01	7E-02	9E-02	NA	NA	NA
Surface Water						
Dermal Contact	1E-01	3E-02	4E-02	NA	NA	NA
Incidental Ingestion	9E-02	9E-03	2E-02	NA	NA	NA
Subtotal of Media	1E-01	4E-02	5E-02	NA	NA	NA
Total	6E-01	1E-01	1E-01	1E-03	NA	1E-02

* = Chemical-Specific Risks are presented in Appendix A..
** = Either no COPCs were selected or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not Applicable, pathway is not applicable for the respective media.

4.2.7.5.1 Carcinogenic Risks

The estimated carcinogenic risk for future residents (6E-05), trespasser adults (1E-05), and trespasser adolescent (8E-06) are within the EPA target risk range of 1E-04 to 1E-06. Dermal contact with sediment and surface water for the future resident have incremental cancer risks of 2E-05 and 2E-05, respectively. These exposure routes contribute the most to the cumulative carcinogenic risk for the future resident. The dermal contact with COPC route is associated with high uncertainty based on the $ASBSEFF_{oral}$ presented in Appendix G, Section 3.2.3.4. The 1E-04 to 1E-06 risk range is often used by EPA in setting standards and criteria and in determining the need for environmental remediation.

The principal COPCs contributing to these cancer risks were 4,4'-DDD (sediment and surface water) and 4,4'-DDT (sediment and surface water) for the hypothetical future resident and trespasser scenarios. The estimated carcinogenic risks for the maintenance worker (1E-07) and occupational worker (9E-07) are less than 1E-06. No quantitative carcinogenic risk was estimated for excavation workers because no COPCs were selected in subsurface soils. Chemical-specific risks are presented in Appendix A.

4.2.7.5.2 Noncarcinogenic Risks

The cumulative HIs for all potential receptors at SWMU 2 are less than 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. No quantitative noncarcinogenic risk was calculated for excavation workers because no COPCs were selected in subsurface soils. Chemical-specific risks are presented in Appendix A.

4.2.7.5.3 IEUBK Lead Results

The IEUBK Lead Model (v. 0.99) was used to characterize potential effects associated with exposure to media containing lead. The model was run two ways: using the representative concentration and using the average concentration. The purpose of this was to give the risk manager a range of risks based on a conservative exposure (using the representative concentration) and an average exposure (using the average concentration). 1.) Using the representative concentration - Based on model results, 0.02 percent of residential children exposed under similar conditions might have blood-lead levels exceeding 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels exceeding 10 µg/dL (EPA, 1994). The assumed model inputs were the default parameter values, 55.4 mg/kg lead in site-related soils, and 2.5 µg/L lead in groundwater. 2.) Using the average concentration - Based on model results, 0.00 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL (EPA, 1994). The model inputs assumed were default parameter values, 15.9 mg/kg lead in site-related soils, and 2.2 µg/L lead in groundwater. The IEUBK histograms for background and SWMU 2 exposures are in Appendix A.

4.2.7.5.4 Groundwater and the Quantitative Risk Assessment

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, nonpotable water by FDEP. As discussed in Section 3 and in Appendix G, Section 3.2.2.2, groundwater obtained from the surficial aquifer at Key West has a high salinity, and the public water supply obtained from the mainland is officially designated as the only potable source. No freshwater public or registered domestic wells exist, although domestic wells are reportedly used for purposes such as flushing water. Although treatment could possibly be used to improve water quality, the local water authority regulates all potable supplies in the Keys. A preliminary comparison of groundwater concentrations at the SWMU 2 versus tap water RBCs (EPA, 1995b) and MCLs (EPA, 1995c) is presented in Tables 4-51 and 4-52. The results of this preliminary comparison for SWMU 2 are presented in this section.

The maximum values of 1,1-DCE, 1,2-DCE (total) benzene, cis-1,2-DCE, methylene chloride, vinyl chloride, TCE, antimony, and thallium exceeded both their respective MCL and RBC values. Antimony was detected in five out of 11 samples at levels above the MCL and above the tap water RBC. However, positive detections were obtained from the 1990 and 1993 sampling events and this data may be suspect (see Section 4.2.6.3). Thallium was detected in three out of 11 samples at levels above the MCL and above the tap water RBC. 1,1-DCE was detected in two out of eight samples at levels in excess of the tap water RBC, while only the maximum concentration exceeded the MCL. 1,2-DCE (total) was detected in one out of two samples at levels above the MCL and above the tap water RBC. 1,2-DCE (cis isomer) was detected in one out of five samples at levels above the MCL and above the tap water RBC. Vinyl chloride was detected in one out of eight samples at a level which slightly exceeded the MCL and was also greater than the RBC. Benzene was detected in two out of eight samples at levels approximately 10-fold greater than the MCL and also greater than the RBC. Methylene chloride, which is a common laboratory contaminant, was detected in three out of eight samples at levels which ranged from below the quantitation limit to approximately twice the quantitation limit.

The maximum values of chlorobenzene, 1,4-DCB, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, alpha-BHC, beta-BHC, arsenic, and beryllium exceeded their respective RBC values. Chlorobenzene and 1,4-DCB were detected in six out of eight samples and four out of seven samples, respectively. Chlorobenzene was generally present at a level which slightly exceeded the tap water RBC and 1,4-DCB was generally

TABLE 4-51

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs INORGANICS IN GROUNDWATER - SWMU 2 (µg/L) NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	0/3	Not detected	–	3/7	717-3,000	679.79	NL	NA	37,000	N
Antimony	0/5	Not detected	–	5/11	41-88	29.05	6	Y	15	Y
Arsenic	3/6	4.1-11.9	4.33	9/11	2.6-24.65	12.25	50	N	0.045	Y
Barium	6/6	6.6-19.45	13.9	11/11	12.6-52.3	30.16	2,000	N	2,600	N
Beryllium	0/6	Not detected	–	1/11	1.1	0.43	4	N	0.016	Y
Calcium	3/3	114,250-243,500	181,000	7/7	147,000-1,460,000	696,000	NL	NA	NL	NA
Chromium	2/6	0.71-13	4.09	6/11	12.1-33.7	10.70	100	N	180	N
Cyanide	2/3	2.4-5.525	2.76	1/7	14.2	10.77	200	N	730	N
Iron	2/3	76.9-97.4	62.6	5/7	90.8-1,700	427.69	NL	NA	11,000	N
Lead	1/5	2.5	1.19	4/11	2.5-5.4	4.53	15	N	NL	NA
Magnesium	3/3	123,750-820,250	433,000	7/7	159,000-719,000	387,857	NL	NA	NL	NA
Manganese	2/3	3.9-10.3	4.87	5/6	2.7-25.1	12.10	NL	NA	180	N
Mercury	1/6	0.13	0.08	5/11	0.13-0.25	0.13	2	N	11	N
Potassium	3/3	38,850-181,750	119,000	7/7	51,500-178,000	108,629	NL	NA	NL	NA
Sodium	3/3	982,250-6,615,000	3,670,000	7/7	1,460,000-6,010,000	3,288,571	NL	NA	NL	NA
Sulfide	3/3	10,000-52,000	28,000	1/1	47,750	47,750	NL	NA	NL	NA
Thallium	1/6	4.925	2.52	3/11	6.7-11.7	6.42	2	Y	2.9	Y
Tin	0/3	Not detected	–	2/5	48.4-81.9	35.06	NL	NA	22,000	N
Zinc	3/6	3.425-15.3	4.94	7/12	8.3-49	13.37	NL	NA	11,000	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum contaminant level (EPA, 1995c).
**RBC = Risk-based concentration (EPA, 1995b).

TABLE 4-52

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs
ORGANICS IN GROUNDWATER - SWMU 2 (µg/L)
NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDD	0/6	Not detected	–	7/11	0.76-56	8	NL	NA	0.28	Y
4,4'-DDE	0/6	Not detected	–	9/12	0.044-22	2.62	NL	NA	0.2	Y
4,4'-DDT	0/6	Not detected	–	6/12	0.16-30	4.14	NL	NA	0.2	Y
Aldrin	0/6	Not detected	–	1/11	2.8	0.41	NL	NA	0.004	Y
Alpha-BHC	0/6	Not detected	–	2/12	0.16-14	1.28	NL	NA	0.011	Y
Beta-BHC	0/6	Not detected	–	6/12	0.054-5	0.67	NL	NA	0.037	Y
Delta-BHC	0/6	Not detected	–	5/12	0.12-13	1.38	NL	NA	NL	NA
Endosulfan I	0/6	Not detected	–	1/11	0.039	0.15	NL	NA	220	N
SEMIVOLATILE ORGANIC COMPOUNDS										
1,2,4-trichlorobenzene	0/3	Not detected	–	2/3	4-15.5	8.17	70	N	190	N
1,2-dichlorobenzene	0/4	Not detected	–	4/7	2.8-3.6	2.70	600	N	270	N
1,3-dichlorobenzene	0/4	Not detected	–	5/7	2-8.2	4.75	600	N	540	N
1,4-dichlorobenzene	0/4	Not detected	–	4/7	7-37	9.87	75	N	0.44	Y
2-methylnaphthalene	0/4	Not detected	–	1/3	53	21.08	NL	NA	1,500	N
4-methylphenol	0/4	Not detected	–	1/3	2	4.08	NL	NA	180	N
Benzoic acid	0/4	Not detected	–	1/3	4	18.50	NL	NA	50,000	N
Benzyl alcohol	0/4	Not detected	–	1/3	7.75	5.92	NL	NA	11,000	N
Bis(2-ethylhexyl)phthalate	0/4	Not detected	–	2/3	2-3	3.33	6	N	4.8	N
Naphthalene	1/4	2	4.09	1/7	43	7.65	NL	NA	1,500	N
VOLATILE ORGANIC COMPOUNDS										
1,1-dichloroethene	0/3	Not detected	–	2/8	2.25-64.5	9.29	7	Y	0.044	Y
1,2-dichloroethene (total)	0/1	Not detected	–	2/2	3.5-1,500	752	70	Y	55	Y
Acetone	1/3	5	5	2/4	10-93	28.25	NL	NA	3,700	N
Benzene	0/3	Not detected	–	2/8	56-107.5	21.56	5	Y	0.36	Y
Carbon disulfide	0/3	Not detected	–	4/4	2-60	17.25	NL	NA	1,000	N
Chlorobenzene	0/3	Not detected	–	6/8	3.7-167.5	62.71	NL	NA	39	Y
Cis-1,2-dichloroethene	0/3	Not detected	–	1/5	640-840	168.40	70	Y	55	Y
Ethylbenzene	0/3	Not detected	–	3/8	2.8-81.5	13.85	700	N	1,300	N
Methylene chloride	2/3	1	1.5	3/8	1-61	14.84	5	Y	4.1	Y
Toluene	0/3	Not detected	–	2/8	4-70.5	10.44	1,000	N	750	N
Trichloroethene	0/3	Not detected	–	1/8	64	9.24	5	Y	1.6	Y
Vinyl chloride	0/3	Not detected	–	1/8	3.5	18.08	2	Y	0.019	Y
Xylenes (total)	0/3	Not detected	–	3/8	2-73.5	12.05	10,000	N	12,000	N

NA = Not applicable.
NL = Not listed.

*MCL = Maximum contaminant level (EPA, 1995c).
**RBC = Risk based concentration (EPA, 1995b).

present at a level more than 10 times the tap water RBC. 4,4'-DDD and 4,4'-DDE were detected in 7 out of 11 samples and 9 out of 12 samples, respectively. Most results for the 4,4'-DDT degradation products were in a concentration range between the RBC and 100 times the RBC, with all of the higher-level results occurring in samples in the immediate proximity of the former 4,4'-DDT mixing area. Aldrin was detected in one sampling round (1993) in one well at a level that exceeded the RBC by more than 500-fold. Alpha-BHC and beta-BHC were detected in 2 out of 12 samples and 6 out of 12 samples, respectively. Most of the BHC results exceeded the RBC by approximately slightly more than an order of magnitude. Arsenic was detected in 9 out of 11 samples at levels which generally exceeded the RBC by more than an order of magnitude. However, this is not unusual for unfiltered groundwater samples. Beryllium was only detected in one out of 11 samples; the detected level exceeded the RBC by almost two orders of magnitude but was below the contract-required detection limit (CRDL).

4.2.7.5.5 Fish and the Quantitative Risk Assessment

Fish and shellfish at SWMU 2 were not considered a human health concern because site access is prevented by airport security monitoring of the active airfield. A more complete discussion of this subject is presented in Section 3.2.2.3 of Appendix G.

4.2.7.6 Uncertainties for SWMU 2

Beyond the uncertainties associated with the human health risk assessment process discussed in Section 3.2.6 of Appendix G, the following uncertainties should be considered in any evaluation of SWMU 2 risk assessment results:

- The uncertainty associated with the dermal exposure is high because of the derivation of the dermal reference dose (See Appendix G, Section 3.2.3.4). Dermal exposure is a primary contributor to the cumulative cancer risk (via surface water and sediment) for the future residential receptors. The uncertainty associated with the dermal exposure route may overestimate the risk at SWMU 2.
- Beryllium was selected as a COPC in surface soil, but it was detected at levels in SWMU 2 that slightly exceed background levels. The inclusion of beryllium as site-related surface soil COPC could overestimate the quantitative risk at SWMU 2 for the future residential receptor.
- Use of residential RBCs (sediment) and tap water RBCs (surface water) probably influences the selection of COPCs at the site by potential designated chemicals as COPCs that do not contribute significantly to the quantitative risk at SWMU 2 (i.e., pesticides in surface water). This bias is based

on the fact that sediment and surface water exposure is generally well below intakes a receptor would be exposed to under a true residential soil and groundwater exposure pathway.

- Several chemicals, notably pesticides in surface soils and sediment, did not have listed toxicity values for use in the quantitative risk assessment; therefore, no risks were estimated for exposure to the COPCs. These chemicals generally had low frequencies of detection (i.e., generally less than 20 percent of the samples analyzed had detections) and low detected concentrations (as compared to other chemicals in the same class; e.g., pesticides).

- Lead was determined to be a COPC in surface water at SWMU 2. Lead exposure to surface water is not estimated under the IEUBK Lead Model for the baseline HHRA at SWMU 2. This probably underestimates the risks to potential receptors exposed to lead in surface water, especially residential children. Exposure to lead in surface water by residential children is lower than exposure to lead in surface soil at SWMU 2. Therefore, the risks are expected to be lower than those results estimated by exposure to surface soils at SWMU 2 using the IEUBK Lead model.

4.2.7.7 Chemicals of Concern and Remedial Goal Options

This section present the selected chemicals of concern and remedial goal options for SWMU 2.

4.2.7.7.1 Selection of Chemicals of Concern

From the COPCs chosen for each medium in the baseline risk assessment, a subset of chemicals, called COCs, was selected for the evaluation of RGOs. At SWMU 2, COCs were included in the RGO evaluation only if they exceeded ARARs/TBCs (as in the case of pesticides, which exceeded surface water AWQC). Risk-based selection of COCs was not required at SWMU 2 because in no instance did any receptor scenario have a cumulative risk above a level of concern (1E-04 cancer risk or an HI of 1.0). Section 3.2.7 of Appendix G further describes the ARARs, TBCs, and risk-based criteria used in selecting COCs [RCRA Corrective Action Levels, FDEP SCGs, and AWQC]. The COCs selected at SWMU 2 are as follows:

Surface Water - Selections Based on AWQC for Consumption of Aquatic Organisms

- 4,4'-DDD
- 4,4'-DDT
- Aldrin

- Beta-BHC
- Heptachlor

4.2.7.7.2 Remedial Goal Options (RGOs)

RGO cleanup levels based on generic FDEP and RCRA TBCs for COCs in surface soils and sediment (presuming sediment might become future surface soil) are listed in Table 4-53 for residential and occupational work exposure scenarios. Table 4-54 contains RGOs for COCs in surface water based on Federal AWQC (relevant to exposure via consumption of aquatic organisms). The RGOs developed according to site-specific baseline risk assessment assumptions are presented for a range of three target risk levels in Table 4-55. These site-specific RGO options provide the risk manager with a range of values that can facilitate the evaluation of potential remediation strategies. However, the generic TBCs and AWQC are also important inputs for use in decisionmaking. Further explanation of the derivation and assumptions related to these RGOs is presented in Section 3.2.7 of Appendix G.

4.2.7.8 Conclusions

The primary objectives of investigation at SWMU 2 were to identify existing contamination (after the interim remedial action) in the on-site media, provide a baseline HHRA of COPCs identified in those media, and perform an ecological risk assessment.

Noncarcinogenic and carcinogenic human health risks were estimated for potential current (trespasser, maintenance worker, and occupational worker) and hypothetical future residents receptors.

COPCs in SWMU 2 media were not present at sufficient concentrations to cause adverse noncarcinogenic health effects to any current or future potential receptor. The cancer risks estimated for any current or future potential receptors were below or within the 1E-04 to 1E-06 target risk range, often used by EPA in setting standards and criteria and in evaluating the need for environmental remediation.

The future land uses planned for this site (i.e., military base with restricted access or zoned future limited access because of existing conditions; e.g., areas near the active airstrip) do not include residential land use for the foreseeable future.

The results of the baseline HHRA for all media evaluated at SWMU 2 support a decision for no further action.

TABLE 4-53

TO BE CONSIDERED RGO CRITERIA FOR SOILS/SEDIMENT
SWMU 2
NAS KEY WEST

COC	RCRA Subpart S Action Levels (mg/kg)	FDEP Residential Soil Cleanup Goals (mg/kg)	FDEP Industrial Soil Cleanup Goals (mg/kg)
INORGANICS			
Beryllium	0.2	0.2	1
Selenium	400	390	9,900
PESTICIDES/PCBs			
4,4'-DDD	3	4.5	17
4,4'-DDE	2	3	11
4,4'-DDT	2	3.1	12

TABLE 4-54

TO BE CONSIDERED RGO CRITERIA FOR SURFACE WATER
SWMU 2
NAS KEY WEST

COC	Human Health Criteria Organism Consumption (µg/L)
PESTICIDES/PCBs	
4,4'-DDD	0.00084
4,4'-DDT	0.00059
Aldrin	0.00014
Beta-BHC	0.046
Heptachlor	0.00021

NL = Not Listed.

TABLE 4-55

RGOs DEVELOPED FOR PROTECTION OF FUTURE RESIDENT - EXPOSURE TO SURFACE WATER (RECREATIONAL USE) - SWMU 2 NAS KEY WEST

	Carcinogenic Cleanup Levels			Noncarcinogenic Cleanup Levels		
COC*	**1.00E-06**	**1.00E-05**	**1.00E-04**	**0.1**	**1**	**3**
PESTICIDES/PCBs						
4,4'-DDD	0.16	1.6	16	-	-	-
4,4'-DDT	0.06	0.6	6	0.33	3.3	9.8
Aldrin	0.10	1.0	10	1.0	10	30
Beta-BHC	1.5	15	150	-	-	-
Heptachlor	0.12	1.2	12	7.4	74	222

*Concentrations are in µg/L.

4.2.8 Ecological Risk Assessment

This section discusses the results of the ecological risk assessment performed at SWMU 2 through a discussion of the problem formulation, effects characterization, exposure assessment and risk characterization.

4.2.8.1 Problem Formulation

This section presents the ecological problem formulation through a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of ECPCs, assessment and measurement endpoints, and the conceptual site model.

4.2.8.1.1 Habitat Types and Ecological Receptors

Section 4.2.1 (see Figure 4-24) describes the physical setting at SWMU 2. Mangroves still line the eastern portion of the ditch outside the area of soil remediation (see Figure 4-24). The area south of the ditch is characterized by a flat grassy area dominated by cordgrass (*Spartina* sp.) and fringe rush (*Fimbristylis* sp.) with scattered buttonwood trees, providing excellent habitat for the endangered Lower Keys marsh rabbit. Marsh rabbit scat was observed in this area during B&R Environmental site visits. The ditch provides limited aquatic habitat for fish and invertebrates. On several occasions while collecting fish in January 1996, B&R Environmental biologists observed 100 to 200 waterfowl resting and feeding in the lagoon to the east of the site. The waterfowl included American coots (*Fulica americana*), American wigeon (*Anas americana*), blue-winged teal (*A. discors*), and northern shoveler (*A. clypeata*). Great egrets (*Casmerodius albus*) were also observed along the edges of the lagoon. Other wading birds, as well as ospreys and bald eagles, probably use the borrow pit (at least occasionally) for foraging. During January 1996, fish were collected in the ditch and the lagoon near the mouth of the ditch for tissue analysis.

4.2.8.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

The contaminant source at SWMU 2 is the former 4,4'-DDT Mixing Area. The potential contaminant release pathways at the site include combustion, volatilization, wind erosion, overland runoff, and infiltration of contaminants. Constituents in the site soil could volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust could be generated during ground-disturbing activities, such as construction or excavation. These contaminants are dispersed in the surrounding

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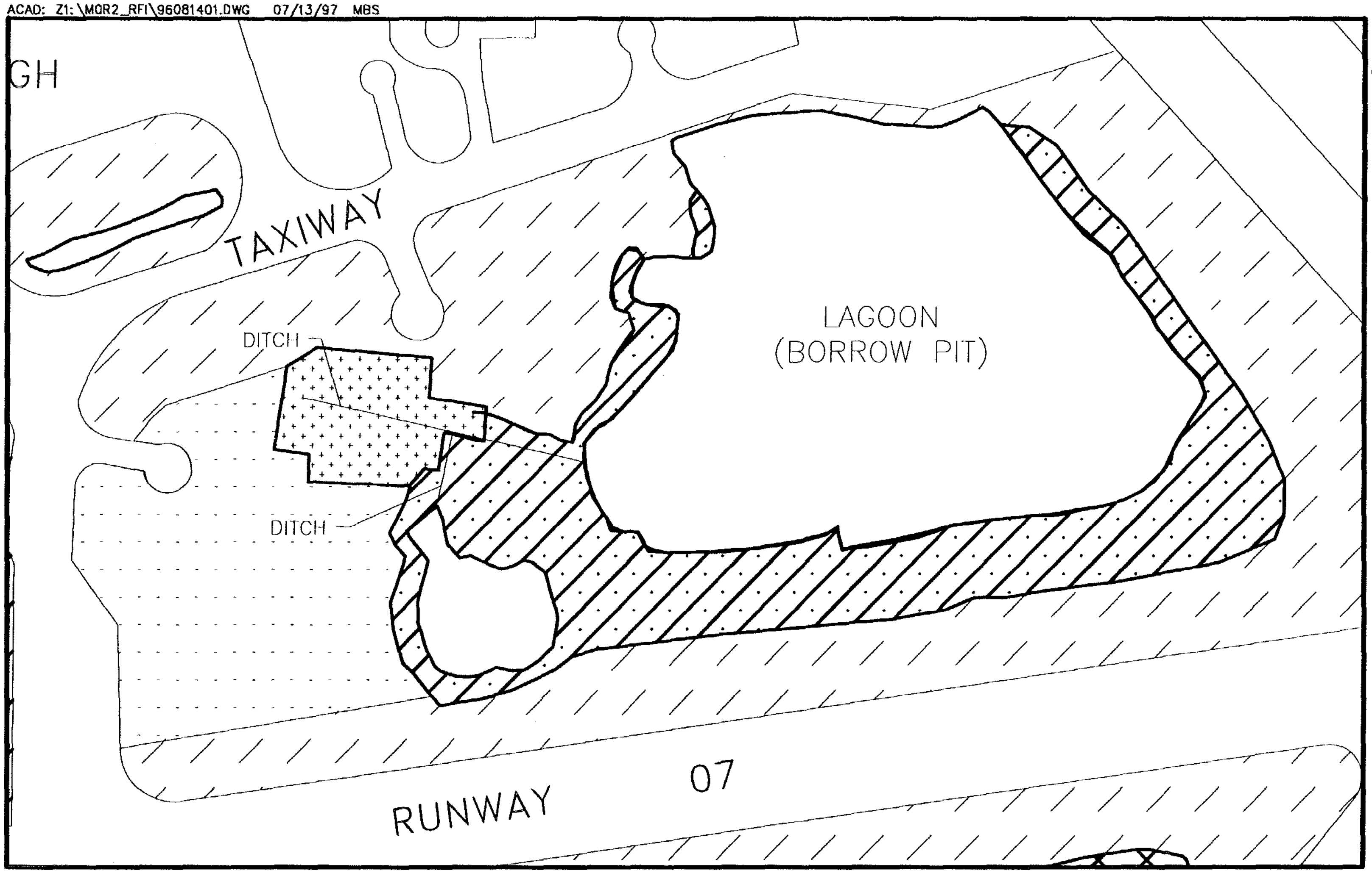

LEGEND

- UPLAND/FILLED (MOWED OR EXOTICS)
- MIXED MANGROVE
- POND/EXCAVATED
- GRASSY UPLAND
- POND/NATURAL
- RECENTLY EXCAVATED (INTERIM REMEDIATION)

Brown & Root Environmental

0 300 600

SCALE IN FEET

FIGURE 4-24. HABITATS AT SWMU 2 DDT MIXING AREA

NAS KEY WEST KEY WEST, FLORIDA

DRAWN BY:	SCALE:	DATE:	REV:
MBS	-	08/08/96	0
CHECKED BY:	CONTRACT NO.:	FILE NAME:	
MLW	-	KEY WEST/T1/96081401.DWG	

environment and transported to downwind locations where they can repartition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition. However, the relatively small site is largely covered with vegetation or water (in the ditch), minimizing airborne transport of contaminants.

Precipitation runoff can carry constituents to nearby surface waters, sediments, and surface soils, especially to surface water and sediments in the ditch and borrow pit. Infiltrating precipitation can cause the contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in soil are likely to migrate at a slower rate. On infiltrating the soil column and reaching the water table, a contaminant can be carried with the flow of groundwater to downgradient locations. Groundwater from the site is shallow and probably is connected with surface water in the ditch and borrow pit lagoon; contaminants can be deposited in sediment or they can accumulate in the tissues of aquatic organisms.

4.2.8.1.3 Exposure Routes

Terrestrial receptors at SWMU 2 can be exposed to soil contaminants through the incidental ingestion of soil and ingestion of contaminated food items. Animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation. Terrestrial receptors can also come into contact with contaminants in surface water by drinking that water. This exposure route, however, usually represents a negligible portion of total exposure for most receptors and the site surface water (in the ditch and lagoon) has a high salt content, precluding its use as a source of drinking water. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatile constituents are present in some site soils, soil-bound contaminant resuspension can occur, and combustion can release contaminants into the air at SWMU 2. However, inhalation does not represent a significant exposure pathway because assumed air contaminant concentrations are quite low, even for burrowing wildlife. In addition, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered to be a route of exposure for ecological receptors.

Aquatic and terrestrial organisms inhabiting the ditch and nearby lagoon can be exposed to contaminants through direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semiaquatic organisms can be exposed to constituents in contaminated groundwater that flows into surface water.

4.2.8.1.4 Selection of Ecological Contaminants of Potential Concern

ECPCs were contaminants detected during current and previous surface-water, sediment, and surface soil sampling at SWMU 2. However, calcium, iron, magnesium, potassium, and sodium were excluded as ECPCs in all media because they are essential nutrients that are toxic only in extremely high concentrations. In addition, inorganic contaminants whose maximum detected concentration is less than two times the average background concentration were excluded as ECPCs. This comparison to background is recommended by EPA (1996) because concentrations of inorganics can be naturally elevated and not due to base-related contaminant releases.

4.2.8.1.5 Assessment and Measurement Endpoints

A detailed description of assessment and measurement endpoints for this environmental risk assessment is presented in Appendix G, Section 3.3.1.1.6.

4.2.8.1.6 Conceptual Site Model

The conceptual model is designed to identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the site were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Figure 4-25 shows a conceptual model for SWMU 2.

4.2.8.2 Ecological Effects Characterization

Ecologically based benchmarks, concentrations of contaminants in various media protective of ecological receptors, were selected to screen against exposure point concentrations of ECPCs in groundwater, surface water, sediment, and soil to determine if they qualify as ECCs at SWMU 2. Groundwater contaminant concentrations were compared to surface-water benchmarks for fresh water. Terrestrial plant benchmarks were obtained for screening potential risks to plants from soil contaminants. Modeling

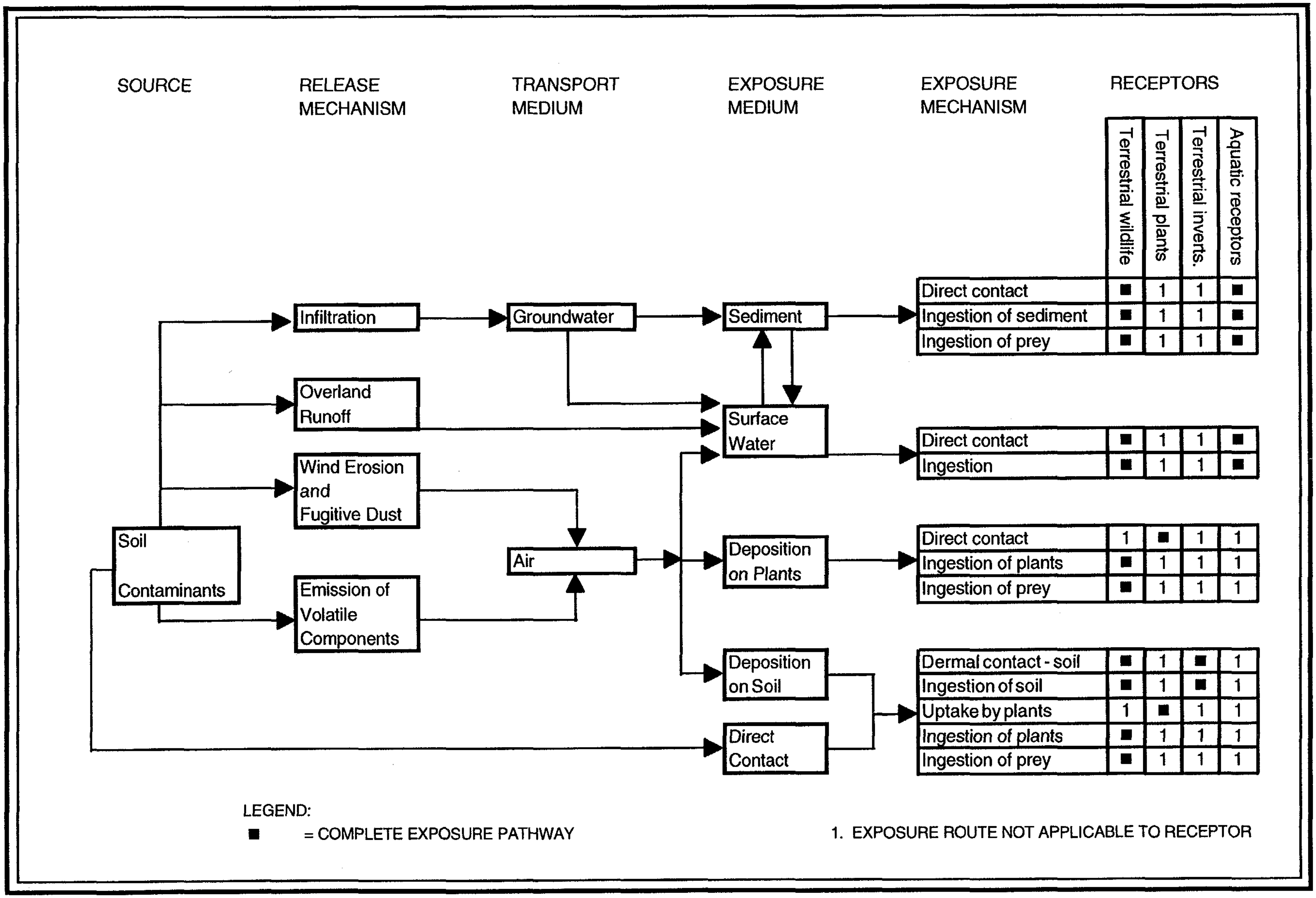

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Figure 4-25. Conceptual Site Model - SWMU 2, NAS Key West, Boca Chica Key, Florida

of contaminant intake doses for an ecological receptor (the Lower Keys marsh rabbit) was also performed, and estimated doses were compared to derived RfDs, which are doses above which potential risks might be present. Groundwater, surface-water, sediment, and surface soil benchmarks used in this risk assessment are presented in Appendix G, as are RfDs used in food-chain modeling in this assessment. Benchmark selection is discussed in Appendix G, Section 3.3.1.2.

Toxicity tests were performed using surface water and sediment collected from the ditch and lagoon at SWMU 2. Four surface-water and sediment samples were collected from the ditch, and one sample was collected from the lagoon near the mouth of the ditch. Surface water was evaluated using the silverside minnow, and sediment was evaluated using the amphipod *Hyallela azteca*. Results of the toxicity tests were compared to results in concurrently tested laboratory control samples.

Fish were collected from the ditch and from the lagoon near the mouth of the ditch and analyzed for volatile organic compounds, semivolatile organic compounds, pesticides, PCBs, and metals. Concentrations of contaminants detected in the fish were compared to concentrations in fish collected at background sites (Table 4-56) and to benchmark concentrations considered to be protective of piscivorous receptors (Table 4-25).

4.2.8.3 Exposure Assessment

This section presents the ecological exposure assessment for SWMU 2 through a discussion of exposure point contaminant concentrations and ecological dose calculations.

4.2.8.3.1 Exposure Point Contaminant Concentrations

Only those analytical results from sampling locations that were outside the area of soil and sediment excavated in interim remediation efforts were used in this ecological risk screening assessment, except sediment samples taken from the excavated area of the ditch during confirmatory sampling after remediation were included in the data base. The maximum detected contaminant concentrations in groundwater, surface water, sediment, and soil were used as exposure point concentrations for screening against benchmark values. Background values were obtained from several locations at NAS Key West. Background sampling is described in detail in Appendix J.

In addition to the current Phase II environmental risk assessment, IT Corporation conducted a preliminary ecological risk assessment at SWMU 2 as part of the RFI/RI activities at NAS Key West (IT Corporation,

TABLE 4-56

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 2 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 1 OF 3

	SWMU 2			Background			
	Frequency of Detection	Range of Detected Values	Average(1)	Frequency of Detection	Range of Detected Values	Average(1)	Average of all Background Values for All Species(1)
INORGANICS							
Arsenic							1.64
Ladyfish	4/4	2 - 3.1	2.6	4/5	0.29 - 0.53	0.33	
Striped mullet	7/8	0.29 - 0.77	0.47	0/2			
Tarpon	4/4	1.7 - 4.1	2.83	NC			
Yellowfin mojarra	5/6	2 - 6.9	2.95	0/3			
Sailfin molly	2/2	0.25	0.25	2/12	0.89 - 1.10	0.25	
Barium							1.01
Ladyfish	1/4	0.49	0.49	0/5			
Striped mullet	1/8	1.4	1.4	0/12			
Yellowfin mojarra	1/6	0.7	0.53	0/3			
Sailfin molly	2/2	3.3 - 4.9	4.1	12/12	1.90 - 3.90	2.88	
Sheepshead minnow	1/1	2.4	2.4	6/6	0.91 - 2.00	1.17	
Copper							3.13
Ladyfish	2/4	0.8 - 1.4	0.80	0/12			
Striped mullet	8/8	0.54 - 7.1	3.48	2/2	1.60 - 3.50	2.55	
Tarpon	2/4	0.85 - 1.3	0.78	NC			
Yellowfin mojarra	4/6	0.49 - 1.2	0.74	0/3			
Sailfin molly	2/2	2.8 - 3.3	3.05	12/12	1.40 - 10.20	4.16	
Sheepshead minnow	1/1	5.1	5.1	6/6	2.80 - 10.30	5.43	
Lead							1.18
Striped mullet	1/8	0.59	0.20	0/2			
Sailfin molly	2/2	0.38 - 0.39	0.39	9/12	0.14 - 5.30	0.60	
Sheepshead minnow	1/1	0.74	0.74	6/6	0.33 - 11.90	7.97	
Mercury							0.03
Ladyfish	4/4	0.04 - 0.08	0.06	2/5	0.05 - 0.06	0.03	
Tarpon	4/4	0.05 - 0.11	0.07	NC			
Selenium							0.35
Ladyfish	1/4	0.31	0.26	0/5			
Striped mullet	1/8	0.57	0.29	2/2	0.28 - 0.38	0.33	
Tarpon	1/4	0.28	0.25	NC			
Zinc							32.4
Ladyfish	4/4	6.5 - 15.7	11.68	5/5	5.0 - 11.2	7.92	
Striped mullet	8/8	10 - 39.7	18.96	2/2	8.50 - 9.00	8.75	
Tarpon	4/4	7.6 - 18	10.33	NC			
Yellowfin mojarra	6/6	8.7 - 23.3	16.97	3/3	17.6 - 248	144.5	
Sailfin molly	2/2	23.7 - 31.2	27.45	12/12	13.60 - 45.40	31.06	
Sheepshead minnow	1/1	31.6	31.6	6/6	23.30 - 45.50	37.02	

TABLE 4-56

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 2 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 2 OF 3

	SWMU 2			Background			
	Frequency of Detection	Range of Detected Values	Average(1)	Frequency of Detection	Range of Detected Values	Average(1)	Average of all Background Values for All Species(1)
PESTICIDES/PCBs							
4,4'-DDD							4.30
Ladyfish	4/4	80.7 - 142	109.23	1/5	1.60	0.72	
Striped mullet	8/8	133 - 1,860	556.38	2/2	2.0 - 3.2	2.6	
Tarpon	4/4	19.7 - 1,880	646.18	NC			
Yellowfin mojarra	6/6	4.6 - 1,770	801.93	2/3	1.60 - 4.60	2.23	
Sailfin molly	2/2	2,510 - 4,20	3,355	10/12	1.8 - 16.6	3.26	
Sheepshead minnow	1/1	384	384	6/6	1.7 - 13.1	7.93	
4,4'-DDE							44.3
Ladyfish	4/4	222 - 599	395.75	5/5	19.4 - 22.8	47.5	
Striped mullet	8/8	414 - 3,000	1,948	2/2	119 - 165	142	
Tarpon	4/4	56.6 - 2,520	959.9	NC			
Yellowfin mojarra	6/6	368 - 1,450	737.83	3/3	73.6 - 282	158.5	
Sailfin molly	2/2	1,630 - 1,73	1,680	12/12	10.3 - 68.3	25.2	
Sheepshead minnow	1/1	452	452	6/6	21.2 - 34.1	26.0	
4,4'-DDT							44.3
Ladyfish	3/4	7.8 - 16.3	8.88	0/5			
Striped mullet	7/8	18.1 - 229	71.6	0/2			
Tarpon	3/4	25.6 - 63.8	30.25	NC			
Yellowfin mojarra	5/6	13.4 - 49.8	22.12	0/3			
Sailfin molly	2/2	74 - 76.7	75.35	1/12	2.00	0.65	
Sheepshead minnow	1/1	19.8	19.8	1/6	2.5	0.84	
Alpha-BHC							ND
Striped mullet	1/8	2.8	1.23	0/2			
Yellowfin mojarra	1/6	3.6	1.43	0/3			
Sailfin molly	2/2	3.4 - 4.7	4.05	0/12			
Arcolor-1260							49.3
Ladyfish	4/4	303 - 669	477	5/5	59 - 182	115	
Striped mullet	8/8	117 - 896	481.63	2/2	75 - 116	95.5	
Tarpon	3/4	127 - 397	173.75	NC(2)			
Yellowfin mojarra	6/6	127 - 271	205.83	3/3	130 - 294	190	
Sailfin molly	2/2	181 - 207	194	8/12	29 - 60	33.3	
Sheepshead minnow	1/1	116	116	2/6	27.0 - 55.0	20.5	
Beta-BHC							1.29
Striped mullet	3/8	7.4 - 11.5	4.28	0/2			
Yellowfin mojarra	1/6	11.3	2.72	3/3	4.20 - 6.30	5.13	
Sailfin molly	1/2	4.8	3	2/12	5.6 - 6.0	1.43	
Sheepshead minnow	1/1	6	6	0/6			

TABLE 4-56

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 2 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 3 OF 3

	SWMU 2			Background			
	Frequency of Detection	Range of Detected Values	Average(1)	Frequency of Detection	Range of Detected Values	Average(1)	Average of all Background Values for All Species(1)
PESTICIDES/PCBs (cont.)							
Delta-BHC							ND
Yellowfin mojarra	1/6	2.6	1.27	0/3			

1 One half the detection limit used for all non-detected values.
NC = Species not collected from background sites during January 1996 sampling.
ND = Not detected in any background sample.

Note: Samples consisted of ladyfish (Elops saurus), striped mullet (Mugil cephalus), tarpon (Megalops atlanticus), yellowfin mojarra (Gerves cinereus), sheepshead minnow (Cyprinodon variegatus), and sailfin molly (Poecilia latipinna). All samples were analyzed for volatiles, semi-volatiles, metals, pesticides, and PCBs. Values for metals are mg/kg (ppm); values for pesticides and PCBs are µg/kg (ppb).

1994). The preliminary assessment compared the maximum contaminant concentrations detected in surface-water, groundwater, and surface soil samples taken as part of field activities to selected background values and various benchmark values. Contaminants were eliminated as potential COCs if they met several criteria, including a maximum concentration less than a conservative benchmark, low mobility or bioaccumulation potential, and detection in less than 5 percent of samples. In addition, the maximum contaminant concentrations in selected media were multiplied by BCFs to obtain predicted contaminant concentrations in prey. Contaminant concentrations in prey were compared to reference toxicity values from the literature for selected receptor species. The results of the preliminary ecological risk assessment for SWMU 2 are presented in Section 4.2.8.4.1.

4.2.8.3.2 Dose Calculations

Potential risks to ecological receptors resulting from exposure to SWMU 2-related contaminants were also evaluated in this assessment by estimating the total contaminant dose an organism inhabiting the SWMU area might receive from each contaminant and comparing the total dose to doses above which adverse effects might occur. Section 3.3.2.1.2 of Appendix G provides a detailed description of dose calculations for this food-chain modeling and lists the exposure parameters used for the Lower Keys marsh rabbit, which was selected as the representative terrestrial receptor for food-chain modeling at SWMU 2.

4.2.8.4 Risk Characterization

This section present the results and a discussion of the ecological risks at SWMU 2.

4.2.8.4.1 Results

The results of the ecological risk characterization at SWMU 2 are presented in this section with a discussion of the results from the Phase I and Phase II ecological screening assessments, food-chain modeling for the Lower Keys marsh rabbit, toxicity assessment, and tissue analyses.

4.2.8.4.1.1 Phase I - Ecological Screening Assessment

The Phase I ecological risk assessment identified antimony, tin, several PAHs, and several pesticides in the groundwater. In surface water, the inorganics barium, lead, silver, and tin, and the pesticides beta-BHC, 4,4'-DDD, and heptachlor were COCs. For sediments, several metals, two phthalates, and several pesticides were identified as COCs, and in soils, several metals, PAHs, and pesticides were identified as COCs. In addition, the Phase I study indicated that concentrations of COCs present in surface water and soil might induce adverse effects in ecological receptors. Piscivores appeared to be at greatest potential risk from pesticides in food items, while fish appeared to be at greatest potential risk from pesticides in surface water. Incidental ingestion of soil posed a high potential risk to terrestrial receptors, though contaminated forage appeared to present only moderate potential risks.

4.2.8.4.1.2 Phase II Ecological Screening Assessment

In groundwater, the inorganics aluminum (HQ = 34.48), barium (HQ = 13.4), beryllium (HQ = 8.46), chromium (HQ = 3.06), cyanide (HQ = 2.73), lead (HQ = 4.09), mercury (HQ = 20.8), and thallium (HQ = 1.86) exceeded benchmarks and were retained as ECCs (Table 4-57). For organics in groundwater, total xylenes (HQ = 40.8), 1,4-DCB (HQ = 3.3), bis(2-ethylhexyl) phthalate (HQ = 10), 1,1-dichloroethene (HQ = 20.2), benzene (HQ = 1.5), 4,4'-DDD (HQ = 8,750), 4,4'-DDE (HQ = 2.1), 4,4'-DDT (HQ = 50,847), aldrin (HQ = 20,000), and beta-BHC (HQ = 108.7) exceeded benchmarks and were conservatively retained as ECCs. Tin and several organics were conservatively retained as ECCs because no suitable benchmarks were available.

In SWMU 2 surface water, four inorganics exceeded benchmark values and were retained as ECCs, including aluminum (HQ = 1.0), lead (HQ = 9.57), silver (HQ = 683), and tin (HQ = 1,000) (Table 4-58). For organics in surface water, the organochlorine pesticides 4,4'-DDD (HQ = 58), 4,4'-DDT (HQ = 550), beta-BHC (HQ = 1.43), aldrin (HQ = 786), and heptachlor (HQ = 295) exceeded benchmarks and were retained as ECCs. Benzyl alcohol was conservatively retained as an ECC in surface water because no suitable threshold was available. In sediments, the inorganics cadmium and zinc exceeded the most conservative benchmarks available and were retained as ECCs, but did not exceed less conservative values (Table 4-59). For organics in sediment, the pesticide 4,4'-DDT, its degradation products, and endrin exceeded both most and less conservative benchmarks. One phthalate compound exceeded the most conservative available benchmark and was retained as a final ECC, but did not exceed a less conservative value. In addition, delta-BHC and endosulfan I exceeded the only benchmarks available and were retained as ECCs. 2-butanone was conservatively retained as an ECC in sediments because no suitable benchmark was available.

Three inorganics in surface soil exceeded benchmarks and were retained as ECCs: aluminum (HQ = 10.2), cyanide (HQ = 3,600), and tin (HQ = 6.97) (Table 4-60). Three organic compounds in surface soils exceeded benchmarks and were retained as ECCs: 4,4'-DDD (HQ = 3.16), 4,4'-DDE (HQ = 11.6), and 4,4'-DDT (HQ = 44). Antimony, beryllium, 2-butanone, acetone, alpha-, beta-, and delta-BHC, bis(2-ethylhexyl)phthalate, and toxaphene were conservatively retained as ECCs because no

TABLE 4-57

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 2
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Aluminum	3/7	ND	717 - 3,000	87	34.48	Retained - HQ > 1
Antimony	5/11	ND	41 - 88	4,300	0.02	Eliminated - does not exceed threshold
Arsenic	9/11	4.33	2.6 - 24.65	50	0.49	Eliminated - does not exceed threshold
Barium	11/11	13.88	12.6 - 52.30	3.9	13.4	Retained - HQ > 1
Beryllium	1/11	ND	1.1	0.13	8.46	Retained - HQ > 1
Chromium	6/11	4.09	12.1 - 33.7	11	3.06	Retained - HQ > 1
Cyanide	1/7	2.76	14.2	5.2	2.73	Retained - HQ > 1
Lead	4/11	1.19	2.5 - 5.4	1.32	4.09	Retained - HQ > 1
Manganese	5/6	4.82	2.7 - 25.1	80	0.31	Eliminated - does not exceed threshold
Mercury	5/11	0.08	0.13 - 0.25	0.012	20.8	Retained - HQ > 1
Thallium	3/11	3	6.7 - 11.7	6.3	1.86	Retained - HQ > 1
Tin	2/5	ND	48.4 - 81.9	NA		Retained - no suitable threshold was available
Zinc	7/12	4.94	8.3 - 49	58.9	0.83	Eliminated - does not exceed threshold
PESTICIDES/PCBs						
4,4'-DDD	7/11	ND	0.76 - 56	0.0064	8,750	Retained - HQ > 1
4,4'-DDE	9/12	ND	0.04 - 22	10.5	2.10	Retained - HQ > 1
4,4'-DDT	6/12	ND	0.16 - 30	0.00059	50,847	Retained - HQ > 1
Aldrin	1/11	ND	2.8	0.00014	20,000	Retained - HQ > 1
Alpha-BHC	2/12	ND	0.16 - 14	500	0.028	Eliminated - does not exceed threshold
Beta-BHC	6/12	ND	0.05 - 5	0.046	108.7	Retained - HQ > 1
Delta-BHC	5/12	ND	0.12 - 13	500	0.026	Eliminated - does not exceed threshold
Endosulfan I	1/11	ND	0.04	0.056	0.71	Eliminated - does not exceed threshold
SEMIVOLATILE ORGANIC COMPOUNDS						
1,2,4-trichlorobenzene	2/3	ND	4 - 15.50	44.9	0.34	Eliminated - does not exceed threshold
1,2-dichlorobenzene	4/7	ND	2.8 - 3.6	15.8	0.23	Retained - does not exceed threshold
1,3-dichlorobenzene	5/7	ND	2.0 - 8.2	50.2	0.16	Eliminated - does not exceed threshold
1,4-dichlorobenzene	4/7	ND	7.0 - 37.0	11.2	3.3	Retained - HQ > 1

TABLE 4-57

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 2
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (cont.)						
2-methylnapthalene	1/3	ND	53	NA		Retained - no suitable threshold was available
4-methylphenol	1/3	ND	2.0	NA		Retained - no suitable threshold was available
Benzoic acid	1/3	ND	4	NA		Retained - no suitable threshold was available
Benzyl alcohol	1/3	ND	7.75	NA		Retained - no suitable threshold was available
Bis(2-ethylhexyl)phthalate	2/3	ND	2 - 3	0.3	10	Retained - HQ > 1
Naphthalene	1/7	4.09	43	62	0.69	Eliminated - does not exceed threshold
VOLATILE ORGANIC COMPOUNDS						
1,1-dichloroethene	2/8	ND	2.25 - 64.50	3.2	20.2	Retained - HQ > 1
1,2-dichloroethene (total)	2/4	ND	3.5 - 1,650	NA		Retained - no suitable threshold was available
Acetone	2/4	5	10 - 93	NA		Retained - no suitable threshold was available
Benzene	2/8	ND	56 - 107.5	71.28	1.51	Retained - HQ > 1
Carbon disulfide	4/4	ND	2 - 60	NA		Retained - no suitable threshold was available
Chlorobenzene	6/8	ND	3.7 - 167.5	195	0.86	Eliminated - does not exceed threshold
Cis-1,2-dichloroethene	1/5	ND	840	NA		Retained - No suitable threshold available
Ethylbenzene	3/8	ND	2.8 - 81.5	453	0.18	Eliminated - does not exceed threshold
Methylene chloride	3/8	1.5	1 - 61	1,930	0.03	Eliminated - does not exceed threshold
Toluene	2/8	ND	4 - 70.5	130	0.54	Eliminated - does not exceed threshold
Trichloroethene	1/8	ND	64	80.7	0.79	Eliminated - does not exceed threshold
Vinyl chloride	1/8	ND	3.5	NA		Retained - no suitable threshold available
Xylenes (total)	3/8	ND	2 - 73.5	1.8	40.8	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-58

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE WATER - SWMU 2
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold Value (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Aluminum	3/3	37.93	33.9 - 1,510	1,500	1.0	Retained - HQ > 1
Antimony	1/4	2.9	13	4,300	0.003	Eliminated - does not exceed threshold
Barium	3/3	9.05	9.8 - 16.3	10,000	0.00016	Eliminated - does not exceed 2 X background
Beryllium	1/3	0.27	0.21	0.13	1.58	Eliminated - does not exceed 2 X background
Lead	1/4	ND	53.6	5.6	9.57	Retained - HQ > 1
Manganese	1/3	3.40	4.05	10	0.41	Eliminated - does not exceed 2 X background
Mercury	1/3	0.12	0.09	0.025	3.6	Eliminated - does not exceed 2 X background
Silver	2/3	ND	6.8 - 8.2	0.012	683	Retained - HQ > 1
Tin	1/2	ND	10	0.01	1,000	Retained - HQ > 1
Vanadium	1/4	2.26	1.65	10,000	0.0002	Eliminated - does not exceed 2 X background
Zinc	3/3	6.51	2.0 - 36.6	86	0.45	Eliminated - does not exceed threshold
PESTICIDES/PCBs						
4,4'-DDD	2/5	ND	0.24 - 1.45	0.025	58	Retained - HQ > 1
4,4'-DDT	1/5	ND	0.33	0.0006	550	Retained - HQ > 1
Aldrin	1/5	ND	0.11	0.00014	786	Retained - HQ > 1
Beta-BHC	1/5	ND	0.15	0.046	3.26	Retained - HQ > 1
Heptachlor	1/5	ND	0.06	0.00021	295	Retained - HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
Benzyl alcohol	1/4	ND	5.0	NA		Retained - no suitable threshold was available
VOLATILE ORGANIC COMPOUNDS						
Acetone	1/2	4.14	13	9,000,000	1.4E-06	Eliminated - does not exceed threshold
Methylene chloride	2/3	1.5	1.00	1,930	0.0005	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-59

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 2
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value(1)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	4/4	2,041.75	459 - 928	NA		Eliminated - does not exceed 2 X background
Antimony	2/3	ND	0.42 - 0.44	12	0.04	Eliminated - does not exceed threshold
Arsenic	3/3	1.71	0.72 - 1.50	7.24	0.21	Eliminated - does not exceed 2 X background
Barium	3/3	9.88	4.5 - 8.70	40	0.22	Eliminated - does not exceed 2 X background
Beryllium	2/3	0.11	0.091 - 0.11	NA		Eliminated - does not exceed 2 X background
Cadmium	4/5	0.42	0.44 - 1.90	0.68/9.6	2.81/0.20	Retained - HQ > 1
Chromium	5/5	6.94	3.0 - 8.10	52.3	0.15	Eliminated - does not exceed 2 X background
Cobalt	2/3	0.88	0.14 - 0.87	50	0.02	Eliminated - does not exceed 2 X background
Copper	5/5	9.01	8.0 - 18.6	18.7	0.99	Eliminated - does not exceed threshold
Lead	5/5	24.65	12.8 - 31.7	30.2/218	1.05/0.15	Eliminated - does not exceed 2 X background
Manganese	4/4	21.95	7.3 - 14	460	0.03	Eliminated - does not exceed 2 X background
Mercury	2/3	ND	0.04 - 0.05	0.13	0.38	Eliminated - does not exceed threshold
Nickel	2/3	2.49	1.4 - 3.30	15.9	0.21	Eliminated - does not exceed 2 X background
Selenium	2/3	1.04	0.44 - 0.56	NA		Eliminated - does not exceed 2 X background
Tin	2/3	2.85	1.60 - 1.80	NA		Eliminated - does not exceed 2 X background
Vanadium	3/3	4.84	2.50 - 4.50	NA		Eliminated - does not exceed 2 X background
Zinc	5/5	30.40	33.3 - 170	124/410	1.37/0.41	Retained - HQ > 1
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	8/10	ND	440 - 17,200	3.3/46	5,212/374	Retained - HQ > 1
4,4'-DDE	8/10	ND	170 - 4,640	1.22/27	3,803/172	Retained - HQ > 1
4,4'-DDT	9/10	ND	16 - 14,800	2.07/46	7,150/322	Retained - HQ > 1
Delta-BHC	2/8	ND	159 - 231	3	77.0	Retained - HQ > 1
Endosulfan I	1/8	ND	359	5.4	66.5	Retained - HQ > 1
Endrin	1/8	ND	244	3.3/3.5	73.9/69.7	Retained - HQ > 1

TABLE 4-59

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 2
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value(1)	Hazard Quotient	Reason for Retention or Elimination as an ECC
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	1/2	2,299	2,500	182/8.90+08	13.7/2.81E-06	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/3	8.80	10	NA		Retained - no suitable threshold was available
Acetone	3/3	34.30	11 - 51	64	0.80	Eliminated - does not exceed threshold
Carbon disulfide	1/3	ND	10	13	0.77	Eliminated - does not exceed threshold
Methylene chloride	3/5	7.60	10 - 53	427	0.12	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

1 When two values are presented, the left value is the most conservative available and the right value is a less conservative value, if available. In these instances, two HQ values are presented. Contaminants were retained as final ECPCs if the most conservative ET value available was exceeded.

TABLE 4-60

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 2
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	4/4	2,130	452 - 6,140	600	10.2	Retained - HQ > 1
Antimony	4/7	0.43	0.25 - 4.70	NA		Retained - no suitable threshold was available
Arsenic	7/7	1.40	0.54 - 2.70	60	0.045	Eliminated - does not exceed 2 X background
Barium	7/7	11.0	7.1 - 14.9	440	0.03	Eliminated - does not exceed 2 X background
Beryllium	6/7	0.05	0.09 - 0.23	NA		Retained - no suitable threshold was available
Cadmium	5/7	0.17	0.12 - 0.84	20	0.042	Eliminated - does not exceed threshold
Chromium	7/7	6.22	2.9 - 11.6	0.4	29	Eliminated - does not exceed 2 X background
Cobalt	4/7	0.34	0.18 - 0.55	200	0.003	Eliminated - does not exceed 2 X background
Copper	6/7	5.28	1.2 - 7.60	50	0.15	Eliminated - does not exceed 2 X background
Cyanide	1/2	ND	18	0.005	3,600	Retained - HQ > 1
Lead	16/17	16.8	0.27 - 55.4	500	0.11	Eliminated - does not exceed threshold
Manganese	4/4	19.4	8.6 - 20.1	100	0.20	Eliminated - does not exceed 2 X background
Mercury	1/7	0.03	0.06	0.1	0.55	Eliminated - does not exceed 2 X background
Nickel	4/7	1.63	0.78 - 3.2	200	0.016	Eliminated - does not exceed 2 X background
Selenium	4/7	0.72	0.33 - 1.2	70	0.017	Eliminated - does not exceed 2 X background
Silver	1/7	ND	0.15	50	0.003	Eliminated - does not exceed threshold
Tin	5/7	1.94	0.71 - 6.2	0.89	6.97	Retained - HQ > 1
Vanadium	6/7	3.71	1.7 - 7.0	20	0.35	Eliminated - does not exceed 2 X background
Zinc	7/7	19.0	1.8 - 23.3	200	0.12	Eliminated - does not exceed 2 X background
PESTICIDES/PCBs (μg/kg)						
4,4'-DDD	26/36	5.71	3.9 - 316	100	3.16	Retained - HQ > 1
4,4'-DDE	33/36	12.38	7.0 - 1,160	100	11.6	Retained - HQ > 1
4,4'-DDT	32/36	7.62	4.95 - 4,400	100	44	Retained - HQ > 1
Aldrin	3/36	ND	1.0	100	0.01	Eliminated - does not exceed threshold
Alpha-BHC	2/36	ND	1.0	NA		Retained - no suitable threshold was available
Beta-BHC	2/36	ND	2.0	NA		Retained - no suitable threshold was available
Delta-BHC	2/36	ND	1.0	NA		Retained - no suitable threshold was available
Endosulfan I	5/36	ND	1.0 - 2.0	100	0.02	Eliminated - does not exceed threshold

TABLE 4-60

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 2
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECC
PESTICIDES/PCBs (μg/kg) (cont.)						
Endosulfan II	2/36	ND	1.0 - 7.0	100	0.07	Eliminated - does not exceed threshold
Endosulfan sulfate	1/36	ND	3.0	100	0.03	Eliminated - does not exceed threshold
Endrin	5/36	ND	2.0 - 7.0	100	0.07	Eliminated - does not exceed threshold
Endrin ketone	1/32	ND	3.0	100	0.03	Eliminated - does not exceed threshold
Gamma-BHC (lindane)	1/36	ND	1.0	100	0.01	Eliminated - does not exceed threshold
Heptachlor epoxide	2/36	ND	6 - 16	100	0.16	Eliminated - does not exceed threshold
Methoxychlor	2/36	ND	3.0 - 9.0	100	0.09	Eliminated - does not exceed threshold
Toxaphene	2/36	ND	91 - 343	NA		Retained - no suitable threshold was available
SEMIVOLATILE ORGANIC COMPOUNDS (μg/kg)						
Bis(2-ethylhexyl)phthalate	2/2	471	200 - 310	NA		Retained - no suitable threshold was available
VOLATILE ORGANIC COMPOUNDS (μg/kg)						
2-butanone	1/6	ND	3.0	NA		Retained - no suitable threshold was available
Acetone	2/6	3.67	29 - 47	NA		Retained - no suitable threshold was available
Cis-1,2-dichloroethene	2/9	ND	6.0 - 8.0	300	0.027	Eliminated - does not exceed threshold
Methylene chloride	2/9	2.80	24 - 27	300	0.09	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

suitable surface soil benchmarks were available. For terrestrial plants at SWMU 2, aluminum (HQ = 122.8) and lead (HQ = 1.1) exceeded benchmarks and were retained as ECCs (Table 4-61). No terrestrial plant benchmarks were available for the organics detected in soils at SWMU 2. Therefore, those compounds and cyanide were conservatively retained as ECCs.

4.2.8.4.1.3 Food-Chain Modeling for the Lower Keys Marsh Rabbit

For the maximum soil contaminant concentration exposure scenario, the total hazard index for the Lower Keys marsh rabbit was 75.4 (Table 4-62). Of this total, antimony (78.3 percent), aluminum (6.8 percent), barium (5.0 percent), cyanide (2.2 percent), and arsenic (1.8 percent) contributed the most to total potential risk. The remaining ECPCs comprised 5.9 percent of the total. Incidental ingestion of contaminated soil accounted for 32.1 percent of the total dose, while ingestion of contaminated forage comprised 67.9 percent of total dose. Ingestion of contaminated drinking water and dermal exposure were considered negligible.

For the mean soil contaminant concentration scenario, the total hazard index was 24.8 (Table 4-63). Antimony (63.7 percent), aluminum (9.5 percent), barium (9.5 percent), cyanide (4.5 percent), and arsenic (3.2 percent) contributed the most to total potential risk, with other ECPCs accounting for 9.4 percent of the total. Incidental ingestion of contaminated soil accounted for 35.2 percent of total dose, and ingestion of contaminated forage constituted 64.8 percent of total dose.

4.2.8.4.1.4 Toxicity Testing

Survival of amphipods in all five sediment samples from SWMU 2 was significantly reduced in comparison to controls; growth of amphipods was significantly reduced in 1 of 5 samples, and somewhat less (but not significantly lower) than controls in two other samples from this site (Table 4-64). Survival of silverside minnows was lower than laboratory controls in three of five samples (but the difference was significant in only one of the three samples), and was similar to control values in the other two samples. Samples 1 and 2 (Table 4-64) were collected from the portion of the ditch that was later excavated during interim site remediation conducted in the Spring of 1996.

4.2.8.4.1.5 Tissue Analysis

Six species of fish were collected from the ditch and lagoon at SWMU 2. Four ladyfish, eight striped mullet, four tarpon, and six yellowfin mojarra were collected in gill nets. Each of these fish comprised an

TABLE 4-61

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR TERRESTRIAL PLANTS - SWMU 2
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECPC
INORGANICS (mg/kg)						
Aluminum	4/4	2,130	452 - 6,140	50	122.8	Retained - HQ > 1
Antimony	4/7	0.43	0.25 - 4.70	5	0.94	Eliminated - does not exceed threshold
Arsenic	7/7	1.40	0.54 - 2.70	10	0.27	Eliminated - does not exceed 2 X background
Barium	7/7	11.0	7.1 - 14.9	500	0.03	Eliminated - does not exceed 2 X background
Beryllium	6/7	0.05	0.09 - 0.23	10	0.02	Eliminated - does not exceed threshold
Cadmium	5/7	0.17	0.12 - 0.84	3	0.28	Eliminated - does not exceed threshold
Chromium	7/7	6.22	2.9 - 11.6	1	11.6	Eliminated - does not exceed 2 X background
Cobalt	4/7	0.34	0.18 - 0.55	20	0.03	Eliminated - does not exceed 2 X background
Copper	6/7	5.28	1.2 - 7.60	100	0.08	Eliminated - does not exceed 2 X background
Cyanide	1/2	ND	18	NA		Retained - no suitable threshold was available
Lead	16/17	16.8	0.27 - 55.4	50	1.1	Retained - HQ > 1
Manganese	4/4	19.4	8.6 - 20.1	500	0.04	Eliminated - does not exceed 2 X background
Mercury	1/7	0.03	0.06	0.3	0.02	Eliminated - does not exceed 2 X background
Nickel	4/7	1.63	0.78 - 3.2	30	0.11	Eliminated - does not exceed 2 X background
Selenium	4/7	0.72	0.33 - 1.2	1	1.2	Eliminated - does not exceed 2 X background
Silver	1/7	ND	0.15	2	0.08	Eliminated - does not exceed threshold
Tin	5/7	1.94	0.71 - 6.2	50	0.12	Eliminated - does not exceed threshold
Vanadium	6/7	3.71	1.7 - 7.0	2	3.5	Eliminated - does not exceed 2 X background
Zinc	7/7	19.0	1.8 - 23.3	50	0.5	Eliminated - does not exceed 2 X background
PESTICIDES/PCBs (µg/kg)						
4,4'-DDD	26/36	5.71	3.9 - 316	NA		Retained - no suitable threshold was available
4,4'-DDE	33/36	12.38	7.0 - 1,160	NA		Retained - no suitable threshold was available
4,4'-DDT	32/36	7.62	4.95 - 4,400	NA		Retained - no suitable threshold was available
Aldrin	3/36	ND	1.0	NA		Retained - no suitable threshold was available
Alpha-BHC	2/36	ND	1.0	NA		Retained - no suitable threshold was available
Beta-BHC	2/36	ND	2.0	NA		Retained - no suitable threshold was available
Delta-BHC	2/2	ND	1.0	NA		Retained - no suitable threshold was available
Endosulfan I	5/36	ND	1.0 - 2.0	NA		Retained - no suitable threshold was available

TABLE 4-61

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR TERRESTRIAL PLANTS - SWMU 2
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention or Elimination as an ECPC
PESTICIDES/PCBs (µg/kg) (cont.)						
Endosulfan II	2/36	ND	1.0 - 7.0	NA		Retained - no suitable threshold was available
Endosulfan sulfate	1/36	ND	3.0	NA		Retained - no suitable threshold was available
Endrin	5/36	ND	2.0 - 7.0	NA		Retained - no suitable threshold was available
Endrin ketone	1/32	ND	3.0	NA		Retained - no suitable threshold was available
Gamma-BHC (lindane)	1/36	ND	1.0	NA		Retained - no suitable threshold was available
Heptachlor epoxide	2/36	ND	6 - 16	NA		Retained - no suitable threshold was available
Methylene chloride	2/9	2.8	24 - 27	NA		Retained - no suitable threshold was available
Toxaphene	2/36	ND	91 - 343	NA		Retained - no suitable threshold was available
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)						
Bis(2-ethylhexyl)phthalate	2/2	471	200 - 310	NA		Retained - no suitable threshold was available
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
2-butanone	1/6	ND	3.0	NA		Retained - no suitable threshold was available
Acetone	2/6	3.67	29 - 47	NA		Retained - no suitable threshold was available
Cis-1,2-dichloroethene	2/2	ND	6.0 - 8.0	NA		Retained - no suitable threshold was available
Methoxychlor	2/36	ND	3.0 - 9.0	NA		Retained - no suitable threshold was available

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-62

MAJOR CONTRIBUTORS TO RISK FOR LOWER KEYS MARSH RABBIT MAXIMUM SOIL CONTAMINANT CONCENTRATION SCENARIO - SWMU 2 NAS KEY WEST

Ecological Contaminants of Potential Concern	Total HI per ECPC for all Pathways	% Contribution of ECPC to Total Receptor HI
Antimony	59.0	78.3
Aluminum	5.1	6.8
Barium	3.8	5.0
Cyanide	1.6	2.2
Arsenic	1.3	1.8
All others	4.5	5.9
Total Receptor HI	75.4	

Pathway	Total HI per Pathway	% Contribution of Pathway to Total Receptor HI
Soil	24.2	32.1
Water	0.0	0.0
Food	51.2	77.9

TABLE 4-63

MAJOR CONTRIBUTORS TO RISK FOR LOWER KEYS MARSH RABBIT MEAN SOIL CONTAMINANT CONCENTRATION SCENARIO - SWMU 2 NAS KEY WEST

Ecological Contaminants of Potential Concern	Total HI per ECPC for all Pathways	% Contribution of ECPC to Total Receptor HI
Antimony	15.8	63.7
Aluminum	2.4	9.5
Barium	2.4	9.5
Cyanide	1.1	4.5
Arsenic	0.8	3.2
All others	2.4	9.4
Total Receptor HI	24.8	

Pathway	Total HI per Pathway	% Contribution of Pathway to Total Receptor HI
Soil	8.7	35.2
Water	0.0	0.0
Food	16.1	64.8

TABLE 4-64

TOXICITY TEST RESULTS - SWMU 2
NAS KEY WEST

Test Type and Endpoint	Sample					
	Control	**1**	**2**	**3**	**4**	**5**
Amphipod 10-day sediment toxicity test (% survival) and total growth (mg)	86.3(1)	56.3*	65.0*	51.3*	67.5*	66.3*
	0.060(2)	0.045	0.029*	0.037	0.068	0.069
Silverside minnow 96-hour toxicity test (% survival)	100/95(3)	100	65.0*	70	70	100

*Sample result significantly different from control.

1 % survival.
2 Total growth in milligrams (mg).
3 Survival was 100% in laboratory controls tested concurrently with samples 1 and 5; survival was 95% in laboratory controls tested concurrently with samples 2, 3, and 4.

individual sample for tissue analysis. Individual weights and lengths of these fish are listed in Table 4-65. Relatively few minnows were trapped in minnow traps, resulting in only two composited samples of sailfin mollies and one of sheepshead minnows. Analytes detected in fish samples consisted of arsenic, barium, copper, lead, mercury, selenium, zinc, Aroclor-1260, alpha-BHC, beta-BHC, delta-BHC, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT (Table 4-56).

4.2.8.4.2 Discussion

Several inorganic and organic contaminants were identified as ECCs in groundwater. Extremely high hazard quotients were noted for 4,4'-DDD, 4,4'-DDT, aldrin, and beta-BHC, due to high values detected from 1991 through 1993 in a single monitoring well (MW 5-1) at the northern edge of the excavated area. Although groundwater is not available to ecological receptors, it could become available by discharging to surface water or sediment.

In surface water at SWMU 2, hazard quotients were particularly high for silver, tin, heptachlor, aldrin, and 4,4'-DDT. Each of these contaminants (except silver) was detected in only one sample, and tin was not an ECC in sediment. Most sediment contaminants were detected at low concentrations unlikely to pose potential risks to ecological receptors. However, the hazard quotients for 4,4'-DDT and its degradation products, as well as delta-BHC, endosulfan I, and endrin in sediment were indicative of moderately high to high potential risk. Endosulfan I and endrin were detected in only one of eight samples, and delta-BHC was detected in only two of eight samples.

Hazard quotients for most ECCs in surface soil were low, but were relatively high for cyanide and 4,4'-DDT. Cyanide was detected in one of two soil samples (S2SB-4) near the northeastern corner of the excavated area. While the source of cyanide in a single sample is unknown, the presence of 4,4'-DDT in the soil indicates past releases at the site. 4,4'-DDT was detected in 32 of 36 samples, at concentrations ranging from 4.95 to 4,400 µg/kg. Most concentrations were between 40 and 200 µg/kg. The highest concentration (4,400 µg/kg) was detected in sample S2SB-3, slightly north of the excavated area.

The scarcity of terrestrial plant benchmarks for organic compounds precluded a detailed assessment of potential risks to terrestrial plants from organics in surface soil. However, plants do not translocate organics to the extent that they translocate inorganics. Estimated concentrations of most metals in plants were low and not believed to pose significant potential risks. However, a hazard quotient indicative of high potential risk was identified for aluminum.

TABLE 4-65

FISH COLLECTED BY GILL NETS DURING JANUARY 1996
NAS KEY WEST

Species	Sample ID No.	Total Length (mm)	Weight (g)
Tarpon (*Megalops atlanticus*)	S2F-11	570	1,200
	S2F-12	595	1,550
	S2F-13	517	970
	S2F-20	580	1,250
Striped mullet (*Mugil cephalus*)	S2F-01	511	1,500
	S2F-02	545	1,400
	S2F-03	505	1,350
	S2F-14	325	334
	S2F-15	336	340
	S2F-16	380	508
	S2F-17	343	390
	S2F-18	505	1,300
	BG1F-08	530	1,480
	BG1F-09	538	1,250
Ladyfish (*Elops saurus*)	S2F-04	535	720
	S2F-05	532	658
	S2F-06	525	634
	S2F-21	495	522
	BG1F-03	487	516
	BG1F-04	465	488
	BG1F-05	477	478
	BG1F-06	470	560
	BG1F-07	485	500
Yellowfin mojarra (*Gerres cinereus*)	S2F-07	235	167
	S2F-08	235	182
	S2F-09	260	222
	S2F-10	257	223
	S2F-19	223	146
	S2F-22	338	500
	BG1F-01	380	606
	BG1F-02	370	594
	BG1F-10	381	570
Pinfish (*Lagodon rhomboides*)	BG2F-06	247	224
	BG2F-07	225	178
	BG2F-08	261	240
	BG2F-09	250	228
Gray snapper (*Lutjanus griseus*)	BG2F-01	315	414
	BG2F-02	365	698
	BG2F-03	277	300
Sea robin (*Prionotus sp.*)	BG2F-04	246	204
Bluestriped grunt (*Haemulon sciurus*)	BG2F-05	257	256

Note: Fish collected at SWMU 2 are designated by sample ID No. S2F; Fish collected at background locations are designated by sample ID Nos. BG1F and BG2F.

Results of the food-chain modeling indicate a relatively high hazard index of 75.4 under the maximum soil contaminant concentration exposure scenario; the HI was 24.8 under the mean soil contaminant concentration scenario. Under both scenarios, antimony contributed the most to total potential risk. The potential risk due to antimony is probably not as great as that indicated by food-chain modeling. Toxicity data were limited for this metal. As a result, several uncertainty factors were needed to calculate an RfD for antimony. Therefore, the high HI value might be due largely to the uncertainty in toxic effects rather than to potential risk. Further uncertainty in the food-chain model results from the conservative assumption that the marsh rabbit spends all its time foraging on the site. The portion of the site north of the ditch provides marginal habitat for this species, while marsh rabbits south of the ditch presumably forage beyond the limits of site-related contamination. The vast majority of the contaminated area appears to have been excavated, and the site itself is relatively small. Because the home range of the marsh rabbit is approximately 1.2 hectares (USFWS, 1994), it is unlikely that this receptor forages on the site all the time. Thus, the model probably overestimated potential risks to the marsh rabbit.

Based on their low survival in all sediment toxicity test samples, the sediments appear to be toxic to amphipods. Results of silverside minnow toxicity tests are not as definitive. The survival of minnows was lower than laboratory controls in surface-water Sample Nos. 2, 3, and 4, but 100-percent minnow survival occurred in Sample Nos. 1 and 5. Sample Nos. 1 and 2 were collected in the portion of the ditch that was excavated during interim site remediation. The survival of minnows in samples collected outside the excavated area was 70 percent in Sample Nos. 3 and 4, and 100 percent in Sample No. 5. Sample Nos. 3 and 4 were collected from the ditch, and Sample No. 5 was collected from the edge of the lagoon near the mouth of the ditch. Therefore, reduced survival in three of four "ditch" samples suggests that surface water in the ditch was toxic to the minnows, while 100 percent survival in Sample No. 5 suggests that toxicity in lagoon surface water is decreased due to surface-water dilution. However, the reduced survival rates may have been at least partially due to the method in which the minnows were acclimated to the test solutions. The minnows were cultured in water with a salinity of 25 ppt, while the salinity of SWMU 2 surface water samples was 12-13 ppt. As discussed in Appendix J (Background Report), the period during which the minnows were acclimated to the test conditions was less than that specified by protocols. Survival was 95 percent in the laboratory controls (salinity = 10 ppt) tested concurrently with Sample Nos. 2, 3, and 4, indicating that salinity acclimation did not adversely impact the survival of the control minnows. However, it is possible that the salinity acclimation was a stressor which acted synergistically with toxicants to which the SWMU "ditch" organisms were potentially exposed.

Concentrations of metals in fish collected from SWMU 2 were generally similar to concentrations in fish collected at background locations, and were less than concentrations considered hazardous to piscivorous receptors. However, concentrations of arsenic and barium in some fish from SWMU 2 were slightly higher than concentrations in fish from background locations. No protective thresholds for piscivorous receptors were available for arsenic and barium.

Concentrations of Aroclor-1260 (the only PCB detected in fish tissue from SWMU 2) were higher than levels detected in fish from background locations. Concentrations in several samples exceeded the most conservative benchmark available for piscivorous receptors. However, all Aroclor-1260 concentrations were less than the highest benchmark of 3,000 mg/kg. The highest value was 896 µg/kg and the average of all concentrations was less than 500 µg/kg. PCBs are ubiquitous in the environment. Fish collected nationwide and analyzed by the U.S. Fish and Wildlife Service as part of the National Pesticide Monitoring Program contained the following mean values: 892 ppb (1970-1976), 880 ppb (1976-1977), 850 ppb (1978-1979), and 530 ppb (1980-1981) (ATSDR, 1995). PCB concentrations in fish from SWMU 2 were below those values, except in some ladyfish and mullet samples. Overall, because PCBs were not detected in site soil or sediment, and because concentrations of PCBs in fish were low in relation to the highest available benchmark, the presence of Aroclor-1260 in fish from SWMU 2 is not likely to pose a significant risk to aquatic or piscivorous receptors. In addition, the source of contamination at SWMU 2 (pesticide mixing and storage) would not be likely to be a source of PCBs.

Pesticides detected in fish from SWMU 2 consisted of 4,4'-DDT and its degradation products and three BHC isomers. Concentrations of the BHC isomers in SWMU 2 fish were greater than in those in tissue from fish from background locations. However, the concentrations were less than protective thresholds for piscivorous receptors, and the frequency of detection was low in most species collected at SWMU 2. Thus, while the presence of BHC in fish tissue is assumed to be due to site-related activities, the concentrations and frequency of detection do not suggest a significant potential risk to piscivorous receptors. 4,4'-DDE and 4,4'-DDD were detected in all fish samples from SWMU 2. All concentrations exceeded the highest species-specific background values for these contaminants, and most concentrations exceeded the protective threshold value for piscivorous receptors (200 µg/kg). These contaminants were also detected at elevated concentrations in surface water and sediment, so the presence of these contaminants, which are known to bioaccumulate in fish tissue, is not surprising. Their presence at elevated concentrations in fish, groundwater, surface water, and sediment is assumed to be due to site-related activities. The fish were collected at SWMU 2 in January 1996, before the excavation of soil from the site and the removal of sediment from the eastern 250 feet of the ditch. The extent to which the remediation efforts will result in lower concentrations in tissue is unknown.

Overall, with the exceptions of 4,4'-DDD and 4,4'-DDE, concentrations of contaminants in fish tissue do not indicate significant potential risks to piscivorous receptors at SWMU 2. Other surface water ECCs were either not detected in fish or were detected at concentrations indicative of negligible potential risk.

Similarly, with the exceptions of 4,4'-DDE and 4,4'-DDD, the contaminants detected in sediment were not detected in fish tissue at significant levels.

4.2.8.5 Ecological Risk Summary

The Phase I ecological screening assessment concluded that COCs were present in surface water and soil at concentrations associated with adverse effects in ecological receptors. Piscivores appeared to be at greatest potential risk from pesticides in food items, while fish appeared to be at greatest potential risk from pesticides in surface water. Incidental ingestion of soil posed a high potential risk to terrestrial receptors, although contaminated forage appeared to present only moderate potential risks.

The Phase II ecological risk assessment was conducted using samples collected mostly prior to the excavation and removal of soil from areas surrounding the former Pesticide Mixing Area and sediment in the western portion of the ditch, which was conducted in the Spring of 1996. The area north of the ditch provides only marginal terrestrial habitat. The area south of the ditch provides relatively good terrestrial habitat, and is used by the endangered Lower Keys marsh rabbit. The ditch provides fair but limited aquatic habitat for fish and invertebrates. Significant potential risks to aquatic receptors and possibly piscivores are present in surface water and sediment, primarily from organochlorine pesticides.

Hazard quotients for most ECCs in surface soil indicate low potential risk. However, 4,4'-DDT and its degradation products were detected in most soil samples outside the excavated area, and some of the concentrations suggest moderate potential risks to ecological receptors. Potential risks to terrestrial receptors from this pesticide are mitigated by the fact that most of the elevated concentrations were in samples from north of the ditch, where terrestrial habitat is of marginal quality. Estimated potential risks to the Lower Keys marsh rabbit were relatively low using the mean soil contaminant concentrations, after consideration of the mitigating uncertainties and conservative assumptions used in the model. Thus, it appears that site soil contaminants do not pose significant potential risks to the marsh rabbit or other terrestrial receptors.

In summary, the Phase I and Phase II ecological risk assessments appear to be adequate to characterize potential ecological risks at SWMU 2. Significant potential risks to aquatic and piscivorous receptors from 4,4'-DDT and its degradation products in surface water and sediment appear to be present, as evidenced by significant exceedances of benchmark values and the results of toxicity tests and fish tissue analysis. However, despite some elevated levels of pesticides and related potential risks outside the area of recent excavation, most of the contaminated area was removed during the excavation. The extent of the excavation at SWMU 2 includes surrounding areas and the locations where 4,4'-DDT was mixed and stored. For these reasons, the efficacy of the removal action should be evaluated before any additional removal of sediments or soils is initiated. To accomplish this, long-term biomonitoring of pesticides in fish should be conducted to determine if levels of pesticides in site-related receptors decrease over time, which should occur if most of the source has been removed. Therefore, although potential risks might exist outside the area of previous excavation, biomonitoring of SWMU 2 fish should be conducted to see if pesticide concentrations in the aquatic system at the site are ameliorated over time.

4.2.9 Conclusions and Recommendations

The pesticide 4,4'-4,4'-DDT and its degradation products are the most significant contaminants at SWMU 2. These constituents are present in all media including soil and sediment, surface water, and groundwater. Although sediment in the ditch adjacent to SWMU 2 received relatively high contamination from 4,4'-DDT and its degradation products, the interim removal activities in the Spring of 1996 eliminated virtually all sediment in the highly contaminated portion by cleaning the ditch to bare rock. Some levels of 4,4'-DDT and its degradation products still exist in the areas that were underneath the coffer dams used to isolate the ditch during remediation and also in the pond to the east of site. 4,4'-DDT and its degradation products were found at low levels in surface-water samples that were in excess of screening action levels. Pesticides and metals were found in groundwater at the site in a few of the wells; however, levels were generally reduced from maximum levels detected in 1991 and 1994.

In summary, 4,4'-DDT, 4,4'-DDT degradation products, arsenic, and lead were previously widespread at the site in all media samples. The interim remediation completed in 1996 has removed the majority of sediment and soil contamination that was detected above screening action levels at the site. Surface water and groundwater continue to have traces of contamination above screening action levels.

The human health risk assessment for SWMU 2 concluded that the carcinogenic risk for the future residential use scenario, the trespasser adults scenario, and the trespasser adolescent scenario are in the range of 1E-04 to 1E-06. The other use scenarios pose carcinogenic risks of less than 1E-06. In addition, the hazard index of noncarcinogenic risk for all scenarios is less than the threshold of 1.0. Because SWMU 2 is adjacent to a runway, no construction or residential land use will be possible as long as the NAS runways are used for military or commercial aviation. It is likely that, in the foreseeable future, the highest land use possible would be other than residential, and human health risks posed by SWMU 2 would be in a borderline area, below or within the 1E-04 to 1E-06 target risk range.

Both the Phase I screening level ecological risk assessment performed in 1994 by IT Corporation and the Phase II ecological risk assessment performed under this Supplemental RFI/RI study concluded that there are potential risks to aquatic and piscivore receptors from 4,4'-DDT and its degradation products in surface water and sediment. However, the great majority of the contaminated sediment was removed during the interim removal activities in the Spring of 1996. Because the source of ecological risk has been removed from SWMU 2, the implementation of long-term biomonitoring of pesticides in fish would be appropriate to see if levels of site-related pesticides decrease over time, which is likely.

Because borderline human health risk and a substantiated ecological risk exist at SWMU 2, a corrective measures study should be implemented for this site. Remedial actions studied should include no further action (NFA) and future biomonitoring to measure decreases in ecological impact. The need for additional corrective action is questionable until the results of the corrective measures study are available.

4.3 SWMU 3, BOCA CHICA FIRE-FIGHTING TRAINING AREA

This section presents the site-specific evaluation of data for SWMU 3. It includes a discussion of the previous investigations conducted at the site, RFI/RI rationale, site geology and hydrogeology, nature and extent of contamination, contaminant fate and transport, baseline human health risk assessment, and ecological risk assessment. Recommendations for SWMU 3 are presented in Section 4.3.9.

4.3.1 Unit Description

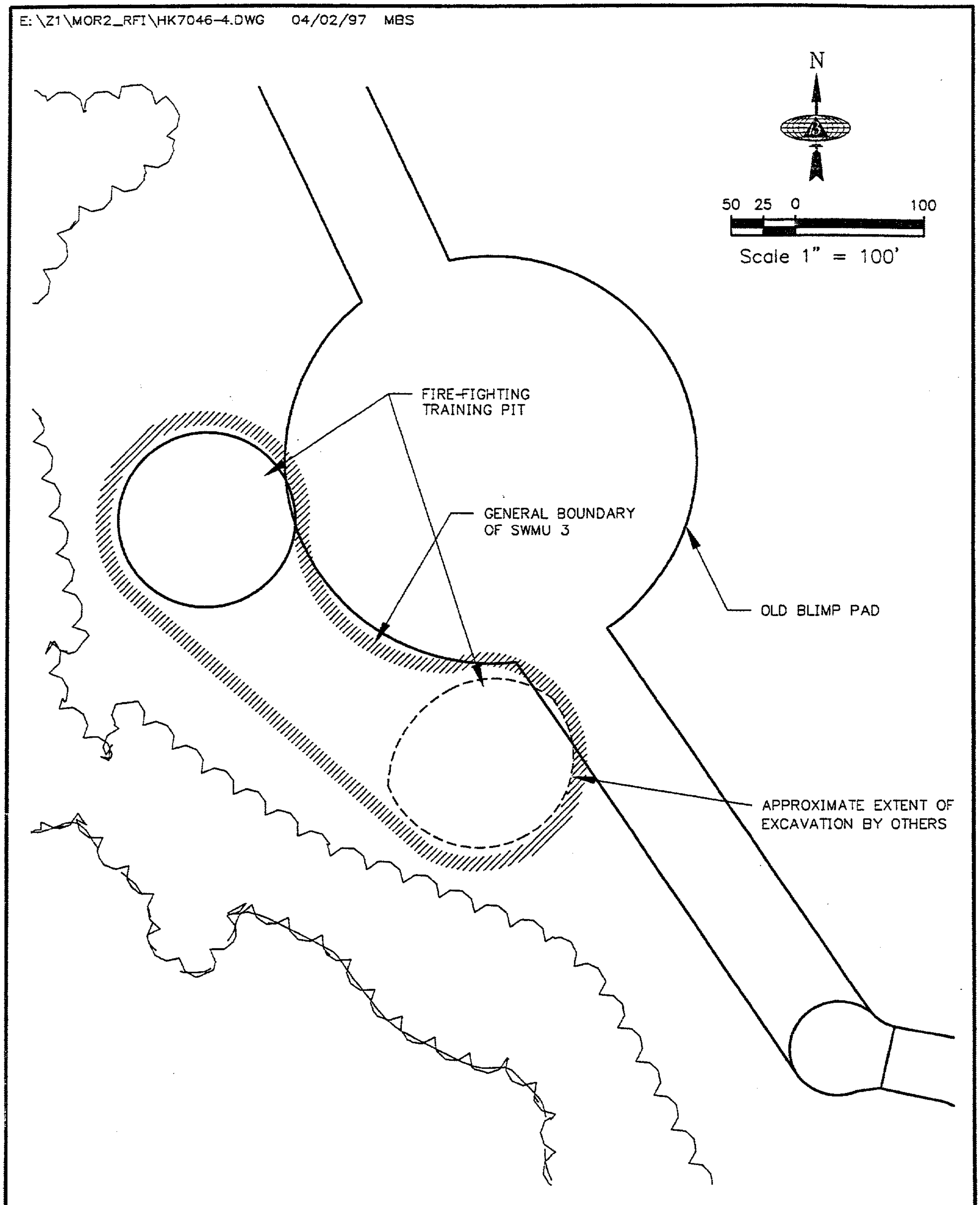
The former fire-fighting training area is a flat, open area located in the southeastern portion of Boca Chica Key, west of the southern blimp pad (Figure 4-26). The site contains aircraft and vehicles that were ignited with JP-5 fuel, waste oil, or hydraulic fluid for use in fire-fighting training. The area also contained two unlined circular pits approximately 20 feet in diameter and two to three feet deep that also received combustible liquids, which were ignited. The former pits are surrounded by gravel aprons. Soil in the southern burn pit was excavated to bedrock and replaced with clean fill material in October 1995 by BEI. Approximately 200 feet to the south and west of the former pits is a 16-acre shallow lagoon that is fringed by a thick growth of red and black mangroves. Water depth in the lagoon ranges from approximately 16 to 26 inches. The lagoon is landlocked and therefore is not connected to open ocean water.

4.3.2 Site-Specific Investigations

This section summarizes the results from the investigations that have been conducted at SWMU 3 through the Spring of 1996. Previous investigations are considered as all investigations that were conducted prior to the Supplemental RFI/RI in January 1996. Current investigations include the Supplemental RFI/RI conducted by B&R Environmental and confirmational sampling conducted by BEI after the interim remedial action.

4.3.2.1 Previous Investigations

Section 1.3 summarizes previous investigations conducted at NAS Key West. This section provides more details regarding the investigations conducted prior to January 1996 at SWMU 3.



SITE MANAGER: RD	CHECKED BY: KW
DRAWN BY: TCB	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-26
SITE LOCATION MAP
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.3.2.1.1 Initial Investigation

Ten soil borings and two shallow monitoring wells (KWM-18 and KWM-19) were installed to a depth of approximately 11 feet in an initial investigation by Geraghty and Miller in 1986. Groundwater quality samples were collected from the monitoring wells and analyzed for VOCs, PCBs, and total dissolved solids (TDS). Results of these analyses indicated that the concentrations of TDS were 2,200 ppm in monitoring well KWM-19 and 38,000 ppm in monitoring well KWM-19. PCBs were not detected in the groundwater samples collected from this site, and only methylene chloride (believed to be an artifact of the analytical laboratory) was detected in the VOC analyses.

4.3.2.1.2 Preliminary Remedial Investigation

IT Corporation conducted a Preliminary RI in 1990 that included the installation of 10 soil borings. Three of these borings were converted to monitoring wells MW10-1, MW10-2, and MW10-3. EP toxicity analysis of soil boring samples did not indicate any detections above established action levels. Several metals, such as cadmium, chromium, and manganese, were detected in the groundwater. Cadmium was detected in only one groundwater sample at concentrations slightly above the action limits established as part of the Preliminary RI, and chromium was detected in two of four wells at concentrations slightly above the established action limit. In addition, manganese was detected in one water sample, and at a level only slightly above the established action limit. Some VOCs were detected in groundwater samples, but these detections of benzene, ethylbenzene, and naphthalene were in one monitoring well. The remaining three monitoring wells showed nondetectable levels of these compounds. Pesticides under TAL analysis were not detected in groundwater samples. One groundwater sample was also analyzed for pesticides under Appendix IX analysis. Matrix interferences produced an elevated quantification limit for analysis. Because of this elevated detection limit, concentrations of pesticides were not accurately quantified.

4.3.2.1.3 RCRA Facility Investigation/Remedial Investigation

IT Corporation conducted an RFI/RI at SWMU 3 during 1993. Results from this investigation indicated that the fire-fighting training conducted in the pits at SWMU 3 resulted in contamination in the groundwater and soil at the site. Five monitoring wells were installed during the RFI/RI (S3MW-1 through S3MW-5) and S3MW-3 contained light nonaqueous phase liquids (LNAPL) on the water table surface. Sampling of the LNAPL determined the source to be either diesel fuel, JP-5 jet fuel, or a combination of both. Monitoring wells MW10-3 and S3MW-5 delineated the groundwater contamination in the southern pit. Monitoring wells associated with the northern pit also contained petroleum hydrocarbon contamination. These wells also contained traces of solvents. The contamination at the north pit was delineated in the southwest direction. At MW10-1 and S3MW-1, vinyl chloride was detected at 17 µg/L and 7.1 µg/L, respectively. The Florida Primary Drinking Water MCL for vinyl chloride is 1 µg/L. Naphthalene was detected at concentrations exceeding the 10 µg/L action level in S3MW-2 and S3MW-4 at 40 µg/L and 15 µg/L, respectively. Antimony and 1,1-dichloroethane (DCA) were also identified as COCs in the groundwater at the site.

Soil samples collected from the center of the pit (S1SB-1, S1SB-2) contained VOCs and PAHs at levels greater than background. The soil borings installed by Geraghty & Miller during the initial investigation delineated the petroleum hydrocarbon contamination in the soils around the fire-fighting pits. Soil boring S3BG-1 was designed to be the soil background sampling location. The sample collected from 1 foot bls at S3BG-1 contained 4,4'-DDT at 0.025 mg/kg, 4,4'-DDD at 0.022 mg/kg, and beta-BHC at 0.010 mg/kg. This sample was eliminated as a background sample during the RFI/RI because these pesticides are not considered to be naturally occurring chemicals in the soils at Boca Chica Key. All of the compounds detected in soil samples collected at the study site were below the RCRA Corrective Action Levels.

Four surface-water samples were collected from the lagoon to the south of the fire-fighting pits. Copper and lead were above Florida Surface Water Quality Standards (FAC 62-302) in a sample collected at S3SS-1. S3SS-1 was originally proposed as a background sample. Lead was detected above background in S3SS-2 and fluoranthene was above background in S3SS-3; however, each of these concentrations were below FAC 62-302 action levels. The contaminants detected in the surface water at SWMU 3 do not seem to result from activities at SWMU 3. Several inorganic and organic compounds were detected above background concentrations in sediment samples at SWMU 3. The compounds present in the sediment samples were not the petroleum hydrocarbons and solvents contained in the groundwater and soil samples. The source of the sediment contamination is probably not associated with SWMU 3.

4.3.2.1.4 Delineation Sampling

In 1995, BEI conducted delineation sampling at SWMU 3. The results from this sampling indicated that benzene, toluene, ethyl benzene, and xylene (BTEX) was not detected in any of the samples above the FDEP cleanup criteria of 200 ppm. BTEX was detected in samples from two locations inside the berm (G17 and K16), ranging in concentration from 3.2 ppm to 30 ppm. Samples from all other locations had results below the detection limit of 2.5 ppm. PAHs were detected in samples from three locations inside the berm (G17, K16, and K12). Low levels of PAHs were detected in surface and subsurface sampling intervals, ranging in concentration from 0.6 ppm to 6.3 ppm total PAHs. A petroleum odor was also evident at these locations beginning at a sampling depth of about 1 foot. The samples collected at all other locations had results below the detection limit of 0.6 ppm. No PAHs were detected in samples collected from locations outside the berm (E12, F17, K11, L18). Analysis of the composite sample of the berm material did not detect the presence of BTEX or PAHs. One split sample was collected at the location K16 at a depth of 3 to 4 feet (Sample ID KW02042). This sample was sent to an offsite laboratory for analysis for BTEX and PAHs. The only detection was one PAH at a concentration of 30.3 ppm; there were no BTEX detections. The field analysis by IMU methodology of this sample had detections of PAHs of 4.5 ppm and BTEX of 4.5 ppm for this sample. The results of the field screening were not as precise as the lab results; however, they were useful in determining the extent of contamination at SWMU 3.

4.3.2.2 Current Investigations

The scope of the Supplemental RFI/RI at SWMU 3 is summarized in Section 4.3.3.1. In addition to the results from the Supplemental RFI/RI, additional data were obtained from the confirmational sampling conducted by BEI in September 1995, after the interim remedial action. These data were accepted and used in the analyses for SWMU 3 to provide a comprehensive analysis of data for making decisions about SWMU 3. Data from the confirmational sampling were not validated, which adds some conservatism to the analyses performed.

4.3.3 RCRA Facility Investigation Rationale

This section presents the reasons for conducting the Supplemental RFI/RI activities at SWMU 3. These reasons are presented in two parts. The first part discusses the scope of the field work performed in January 1996; the second part discusses analytical parameters that were used.

4.3.3.1 Scope of the Field Investigation

Supplemental RFI/RI activities at SWMU 3 included sampling of sediment and surface water, monitoring well installation (S3MW-6 through S3MW-9), and groundwater sampling. Because concentrations of lead in sediments collected from the lagoon shoreline in the original RFI/RI program could be attributable to other sources, this field effort included the collection of sediment samples at locations within the mangrove fringe between the site and the lagoon. Data from the new locations were used to assess whether the lead is attributable to the site or other sources. Monitoring well installation and groundwater sampling were conducted to delineate the extent of vinyl chloride previously detected in groundwater samples.

4.3.3.2 Analytical Parameters

Surface water and sediment were analyzed for the following parameters:

TAL metals	Cyanide

Groundwater was analyzed for:

Appendix IX VOCs	Appendix IX SVOCs

4.3.4 <u>Site Geology and Hydrogeology</u>

The regional geology and hydrogeology of the Florida Keys are presented in Sections 3.4 and 3.5 of this report. The site-specific geology and hydrogeology of the unit were determined from soil borings and monitoring wells installed during the Preliminary RI, the RFI/RI, and the Supplemental RFI/RI.

4.3.4.1 Geology and Soils

The site-specific lithology was determined from split spoon samples collected from three borings performed in association with installation of the monitoring wells. All borings indicated the occurrence of fill material from the surface to an approximate depth of one foot bls. The fill consisted of loosely consolidated sand and gravel, typical of road base construction material. The naturally occurring oolitic limestone was encountered below the fill material and was present to 13 feet, the maximum depth penetrated at the site. The oolitic limestone was well consolidated with abundant brachiopod and bivalve shell fragments and casts. Cavities formed by the dissolution of the limestone were also observed. An anomalous occurrence of peat was observed in boring S3MW-6 at the 8- to 10-foot interval. The limestone was consistent in all other borings. The SPT blow count indicated that the limestone is of medium to light density.

Geotechnical data was obtained from the analysis of a composite soil sample collected from a boring from 2 to 8 feet bls during the Preliminary RI. Geotechnical data included grain size distribution, moisture content, soil pH, cation exchange capacity, total organic carbon content, and permeability. Grain size analysis indicated that the soil is a well-graded, gravely, medium to coarse grained sand with a minor fraction of fine grains (17.8 percent). The pH of the sample was 8, indicative of the naturally occurring carbonate rock. The cation exchange capacity was 44.22 meq/g, which indicates a low cation exchange potential. The TOC value was low (0.73 mg/kg) indicating little organic matter. The permeability value was 9.55E-06 cm/sec which is representative of a fine sand (IT Corporation, 1994).

4.3.4.2 Hydrogeology

Four monitoring wells were installed at the site during the Supplemental RFI/RI. Monitoring well construction logs are included in Appendix K. The construction logs indicate that the depth to groundwater was approximately 2.5 feet bls. Penetration to 13 feet revealed oolitic limestone to that depth. The hydrogeologic unit associated with the oolitic limestone is the surficial aquifer. The presence of large dissolution cavities in the limestone is indicative of an extremely permeable media and high hydraulic conductivity values are likely.

Groundwater elevation data were obtained during the RFI/RI over a 5-week period (April 15, 1993 to May 12, 1993). The first 2 weeks of data indicated a groundwater flow from the site toward the mangroves, while the next 3 weeks of data indicated a northeastern groundwater flow from the mangroves and the lagoon towards the site. Groundwater level measurements taken on January 31 and February 1, 1996, indicate general groundwater flow direction toward the northeast, which is consistent with the average groundwater flow direction reported previously. The reversal of groundwater flow direction observed during the RFI/RI is indicative of a tidal environment and can be expected due to the proximity of the mangroves and the lagoon. Figure 4-27 shows observed groundwater flow directions at SWMU 3.

4.3.5 <u>Nature and Extent of Contamination</u>

The nature and extent of contamination were determined by analyzing samples from soil, sediment, surface water, and groundwater in the vicinity of the Fire-Fighting Training Area. The results of these analyses were compared with the ARAR or SAL that was most restrictive for a given chemical in the given media, shown in Section 2.3.1. The discussion in this section focuses primarily on those chemicals that exceeded the most conservative ARAR/SAL criteria and is accompanied by figures which show the concentrations of certain contaminants of interest (COIs). The COIs were selected based on the criteria presented in Appendix G, Section 3.1.3.2. Appendix L contains the analytical data for all samples.

4.3.5.1 Soil

Chemicals that were detected in surface soil and subsurface soil are listed in Tables 4-66 and 4-67. These tables include analytical results from historical sampling events. Metals were the predominant

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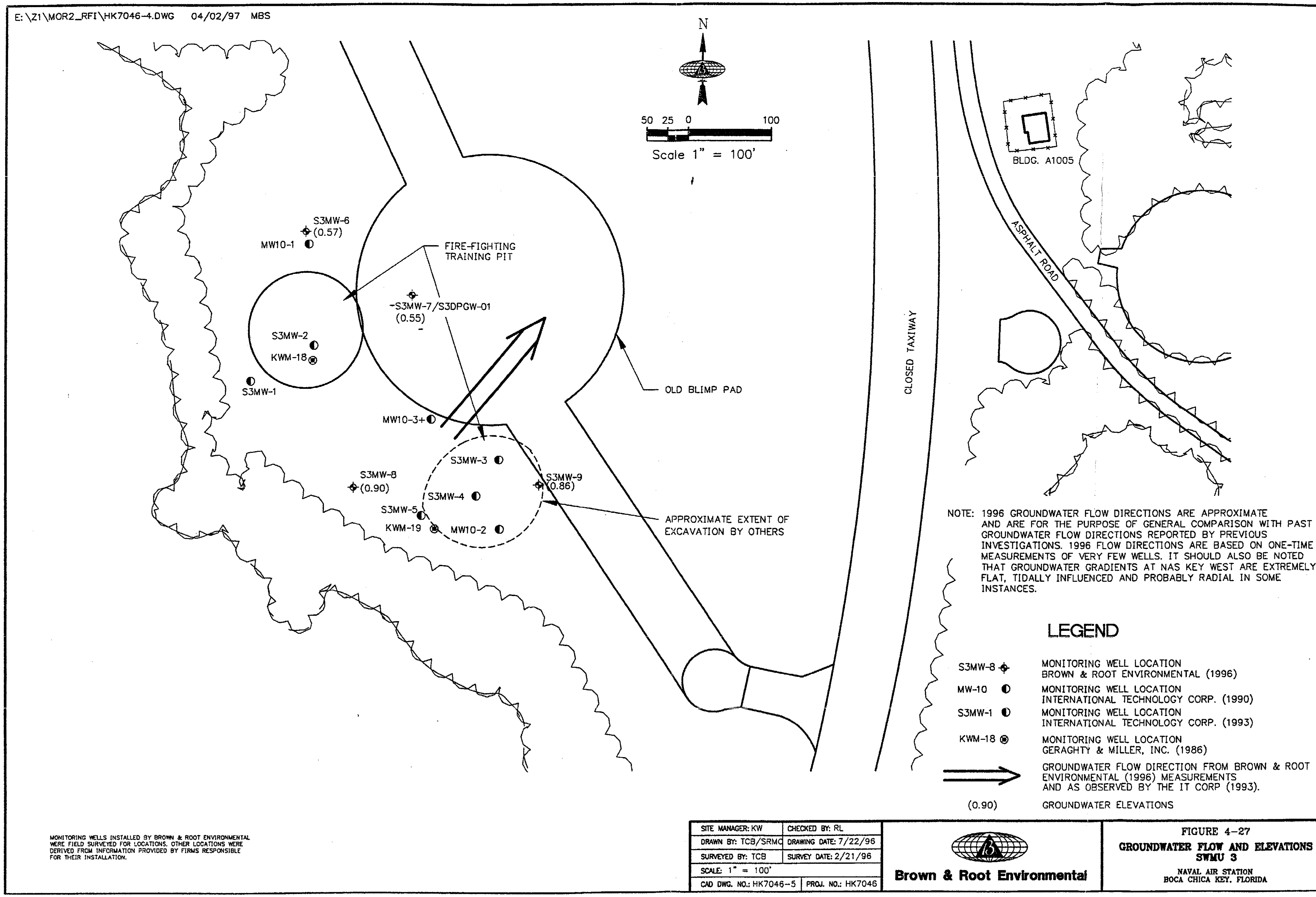

E:\Z1\MOR2_RFI\HK7046-4.DWG 04/02/97 MBS
N
50 25 0 100
Scale 1" = 100'
S3MW-6
(0.57)
MW10-1
FIRE-FIGHTING
TRAINING PIT
-S3MW-7/S3DPGW-01
(0.55)
S3MW-2
KWM-18
S3MW-1
MW10-3+
OLD BLIMP PAD
CLOSED TAXIWAY
BLDG. A1005
ASPHALT ROAD
S3MW-3
S3MW-8
(0.90)
S3MW-4
S3MW-9
(0.86)
S3MW-5
KWM-19
MW10-2
APPROXIMATE EXTENT OF
EXCAVATION BY OTHERS
NOTE: 1996 GROUNDWATER FLOW DIRECTIONS ARE APPROXIMATE AND ARE FOR THE PURPOSE OF GENERAL COMPARISON WITH PAST GROUNDWATER FLOW DIRECTIONS REPORTED BY PREVIOUS INVESTIGATIONS. 1996 FLOW DIRECTIONS ARE BASED ON ONE-TIME MEASUREMENTS OF VERY FEW WELLS. IT SHOULD ALSO BE NOTED THAT GROUNDWATER GRADIENTS AT NAS KEY WEST ARE EXTREMELY FLAT, TIDALLY INFLUENCED AND PROBABLY RADIAL IN SOME INSTANCES.
LEGEND
S3MW-8 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
MW-10 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
S3MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
KWM-18 MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)
GROUNDWATER FLOW DIRECTION FROM BROWN & ROOT ENVIRONMENTAL (1996) MEASUREMENTS AND AS OBSERVED BY THE IT CORP (1993).
(0.90) GROUNDWATER ELEVATIONS
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: RL
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/22/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-5
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-27
GROUNDWATER FLOW AND ELEVATIONS
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

TABLE 4-66

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 3
NAS KEY WEST
PAGE 1 OF 2

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (mg/kg)				
KW02639	09/95	Aluminum	639	
KW02640	09/95	Aluminum	346	
KW02641	09/95	Aluminum	253	
KW02642/02643	09/95	Aluminum	224	
KW02642/02643	09/95	Aluminum	202	
KW02642/02643	09/95	Antimony	0.29	B
KW02640	09/95	Antimony	0.28	B
KW02639	09/95	Antimony	0.24	B
KW02640	09/95	Arsenic	0.68	B
KW02639	09/95	Arsenic	0.55	B
KW02642/02643	09/95	Arsenic	0.44	B
KW02641	09/95	Arsenic	0.28	B
KW02640	09/95	Barium	7.3	B
KW02639	09/95	Barium	7.1	B
KW02642/02643	09/95	Barium	6.4	B
KW02641	09/95	Barium	5.9	B
KW02642/02643	09/95	Barium	5.3	B
S3SB-1	05/93	Barium	5.1	B
KW02642/02643	09/95	Beryllium	0.096	B
KW02639	09/95	Beryllium	0.083	B
KW02640	09/95	Beryllium	0.08	B
KW02642/02643	09/95	Beryllium	0.073	B
KW02641	09/95	Beryllium	0.07	B
KW02640	09/95	Cadmium	0.31	BN
KW02639	09/95	Cadmium	0.059	BN
KW02642/02643	09/95	Cadmium	0.054	BN
KW02642/02643	09/95	Cadmium	0.036	BN
KW02641	09/95	Cadmium	0.021	BN

Location	Date	Parameter	Result	Qual.[1]
KW02640	09/95	Calcium	379,000	
KW02639	09/95	Calcium	376,000	
KW02642/02643	09/95	Calcium	374,000	
KW02641	09/95	Calcium	373,000	
KW02642/02643	09/95	Calcium	369,000	
S3SB-1	05/93	Chromium	3	
KW02639	09/95	Chromium	3	
KW02640	09/95	Chromium	2.7	
KW02642/02643	09/95	Chromium	2.1	
KW02641	09/95	Chromium	2	
KW02642/02643	09/95	Chromium	2	
KW02639	09/95	Cobalt	0.17	B
KW02642/02643	09/95	Cobalt	0.14	B
KW02640	09/95	Copper	3.5	
KW02639	09/95	Copper	0.69	B
KW02641	09/95	Copper	0.48	B
KW02642/02643	09/95	Copper	0.45	B
KW02642/02643	09/95	Copper	0.36	B
KW02639	09/95	Iron	330	E
KW02640	09/95	Iron	220	E
KW02642/02643	09/95	Iron	147	E
KW02641	09/95	Iron	131	E
KW02642/02643	09/95	Iron	112	E
S3SB-1	05/93	Lead	4.6	
KW02639	09/95	Magnesium	1,220	E
KW02641	09/95	Magnesium	1,060	E
KW02640	09/95	Magnesium	1,040	E
KW02642/02643	09/95	Magnesium	999	E
KW02642/02643	09/95	Magnesium	984	E

TABLE 4-66

CONTAMINANTS DETECTED IN SURFACE SOIL - SWMU 3
NAS KEY WEST
PAGE 2 OF 2

Location	Date	Parameter	Result	Qual.[(1)]
INORGANICS (mg/kg) (cont.)				
KW02639	09/95	Manganese	8.6	EN
KW02640	09/95	Manganese	5.4	EN
KW02642/02643	09/95	Manganese	2.6	EN
KW02642/02643	09/95	Manganese	2.5	EN
KW02641	09/95	Manganese	2.2	EN
KW02639	09/95	Nickel	0.78	BN
KW02640	09/95	Nickel	0.46	BN
KW02641	09/95	Nickel	0.45	BN
KW02642/02643	09/95	Nickel	0.45	BN
KW02642/02643	09/95	Nickel	0.41	BN
KW02639	09/95	Potassium	87.2	B
KW02640	09/95	Potassium	72.3	B
KW02642/02643	09/95	Potassium	64.7	B
KW02641	09/95	Potassium	36.9	B
KW02642/02643	09/95	Potassium	33.6	B
KW02640	09/95	Sodium	1,340	
KW02642/02643	09/95	Sodium	1,200	
KW02642/02643	09/95	Sodium	1,110	
KW02641	09/95	Sodium	1,070	
KW02639	09/95	Sodium	1,000	
S3SB-1	05/93	Sulfide	23	
KW02639	09/95	Vanadium	2	B
KW02641	09/95	Vanadium	1.6	B
KW02642/02643	09/95	Vanadium	1.6	B
KW02640	09/95	Vanadium	1.5	B
KW02642/02643	09/95	Vanadium	1.5	B
KW02640	09/95	Zinc	6.6	
S3SB-1	05/93	Zinc	5.6	
KW02639	09/95	Zinc	1.2	B
KW02642/02643	09/95	Zinc	0.92	B
KW02641	09/95	Zinc	0.75	B
KW02642/02643	09/95	Zinc	0.67	B
SEMIVOLATILE (µg/kg)				
KW02640	09/95	Di-n-butyl phthalate	110	J
KW02642/02643	09/95	Di-n-butyl phthalate	91	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S3SB-1	05/93	Acetone	39	
S3SB-1	05/93	Methylene chloride	27	B

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1. Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, 3 of the 1995 BEI Delineation Study.

TABLE 4-67

CONTAMINANTS DETECTED IN SUBSURFACE SOIL - SWMU 3
NAS KEY WEST

Location	Date	Parameter	Results	Qual.[1]
INORGANICS (mg/kg)				
S3SB-1	05/93	Barium	3.7	B
S3SB-1	05/93	Chromium	3.6	
S3SB-1	05/93	Lead	6.8	
S3SB-1	05/93	Sulfide	520	
S3SB-1	05/93	Zinc	25.9	
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S3SB-1	05/93	Ethylbenzene	30	
S3SB-1	05/93	Methylene chloride	21	B
S3SB-1	05/93	Xylenes (total)	37	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1. Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, 3 of the 1995 BEI Delineation Study.

contaminants found in soil at the Fire-Fighting Training Area. Figure 4-28 shows a distribution of soil contamination at the site. Most samples were of surface soil that were taken during delineation sampling around the southern training pit, which has been excavated. A single sample, taken by IT Corporation from the unexcavated northern training pit, was also included in this data set. The data from that point indicate that the most significant soil contamination is still in the immediate vicinity of the excavated training pit. With only a single data point for comparison, a conclusive judgment cannot be made.

To be conservative, contaminant levels discussed in this section were compared to the most restrictive criteria from several sets of ARARs and SALs, including ORNL BTVs, EPA Region III BTAG BTVs, RCRA Subpart S Action Levels, RPRGs, FDEP Residential Cleanup Goals, and FDEP Industrial Soil Cleanup Goals. These criteria can be found in Table 2-3.

4.3.5.1.1 Volatile Organic Compounds

No VOCs were detected in excess of ARAR/SAL criteria in soil samples from the Fire-Fighting Training Area. Acetone and methylene chloride were detected at low levels in surface soil from S3SB-1 in the unexcavated burn area. Ethylbenzene, methylene chloride, and xylene were also detected in the subsurface soil at S3SB-1, but the detected levels were below ARAR/SAL levels.

4.3.5.1.2 Semivolatile Organic Compounds

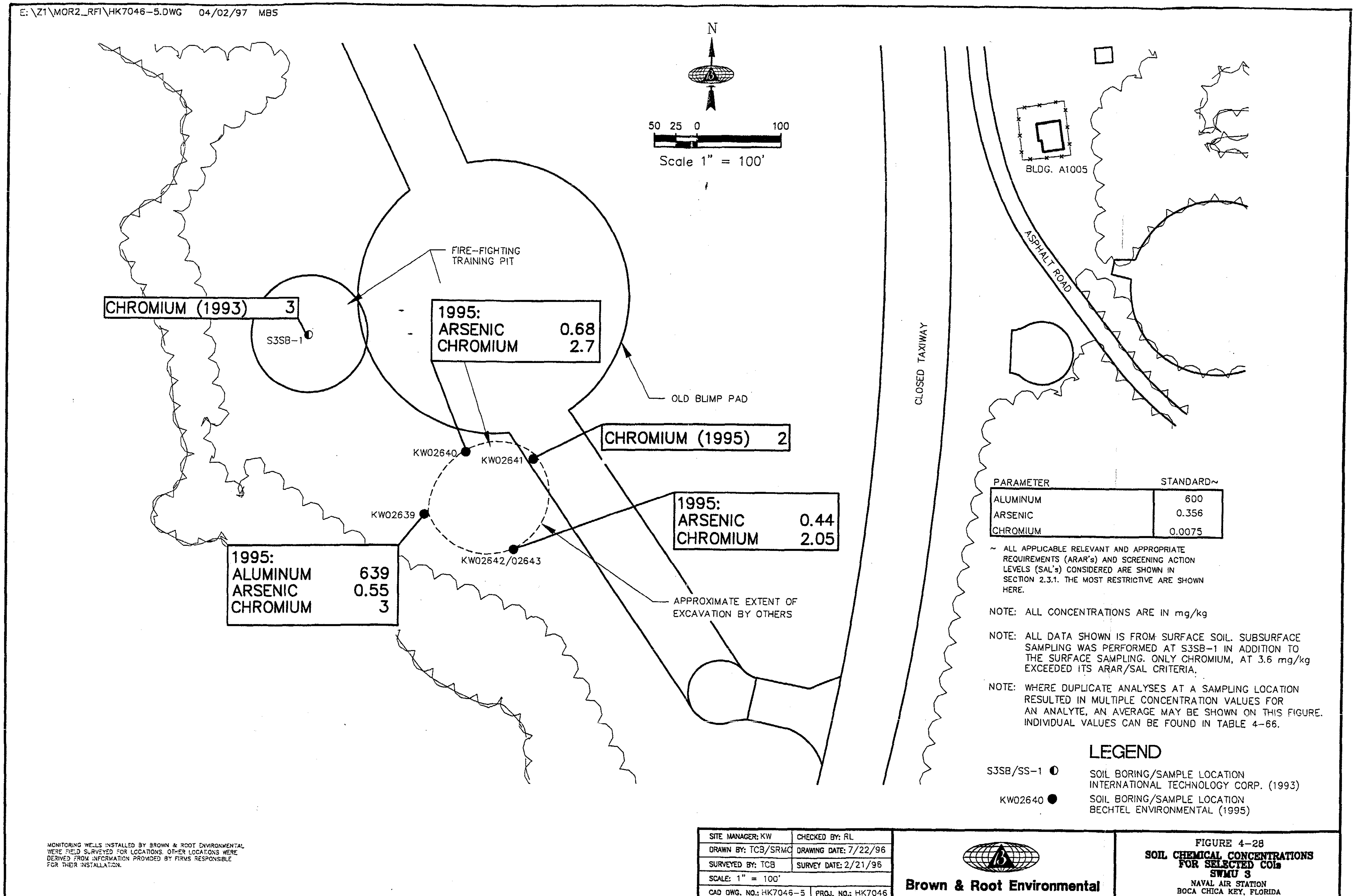
Only a single SVOC was detected in soil at the Fire-Fighting Training Area. Di-n-butyl phthalate was found in two samples in the vicinity of the excavation. The levels detected in both of these occurrences were several orders of magnitude less than the proposed RCRA Subpart S Action Level for that substance.

4.3.5.1.3 Pesticides

No pesticides were detected in surface or subsurface soil at the Fire-Fighting Training Area.

4.3.5.1.4 Polychlorinated Biphenyls

No PCBs were found in the soil at SWMU 3.


E:\Z1\MOR2_RFI\HK7046-5.DWG 04/02/97 MBS
N
50 25 0 100
Scale 1" = 100'
FIRE-FIGHTING TRAINING PIT
CHROMIUM (1993) 3
S3SB-1
1995:
ARSENIC 0.68
CHROMIUM 2.7
OLD BLIMP PAD
CHROMIUM (1995) 2
KW02640
KW02641
KW02639
KW02642/02643
1995:
ARSENIC 0.44
CHROMIUM 2.05
1995:
ALUMINUM 639
ARSENIC 0.55
CHROMIUM 3
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
CLOSED TAXIWAY
ASPHALT ROAD
BLDG. A1005
PARAMETER STANDARD~
ALUMINUM 600
ARSENIC 0.356
CHROMIUM 0.0075
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: ALL DATA SHOWN IS FROM SURFACE SOIL. SUBSURFACE SAMPLING WAS PERFORMED AT S3SB-1 IN ADDITION TO THE SURFACE SAMPLING. ONLY CHROMIUM, AT 3.6 mg/kg EXCEEDED ITS ARAR/SAL CRITERIA.
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-66.
LEGEND
S3SB/SS-1 SOIL BORING/SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
KW02640 SOIL BORING/SAMPLE LOCATION BECHTEL ENVIRONMENTAL (1995)
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: RL
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/22/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-5
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-28
SOIL CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.3.5.1.5 Metals and Inorganics

Aluminum, arsenic, and chromium were the three metals found at the Fire-Fighting Training Area in excess of ARAR/SAL limits. Arsenic and aluminum were found exclusively in the samples from around the excavated training area. Aluminum exceeded the 600-mg/kg ORNL BTV at a single location, KW02639, on the west side of the training pit. The 639-mg/kg concentration at this location was only slightly higher than the limit. Arsenic exceeded the 0.356-mg/kg RPRG at 3 of 4 sampling points surrounding the excavated training area. The maximum value (0.68 mg/kg) was found at the northern edge of the pit. Chromium appears to be the most frequently detected contaminant at the site, exceeding the 0.0075-mg/kg EPA Region III BTV at all surface sampling locations as well as in the subsurface sample. The highest level of chromium was detected in the unexcavated burn area. The subsurface concentration was 3.6 mg/kg, while a surface soil concentration of 3 mg/kg was found in soil at both training areas. Other metals including antimony, barium, beryllium, cadmium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc were also detected at the site, primarily in the vicinity of the excavated area. None of the levels detected approached the ARAR/SAL levels used for comparison.

4.3.5.2 Sediment

To be conservative, contaminant levels discussed in this section were compared to the most restrictive of several sets of ARAR/SAL criteria, including Florida Sediment Quality Guidelines, EPA Region IV Sediment Screening Values, Federal Sediment Quality Criteria, proposed RCRA Action Levels, ER-L Criteria, ER-M Criteria, and EPA SQB. These criteria are all shown in Table 2-4.

Chemicals that were detected in sediment are presented in Table 4-68. This table includes analytical results from historical sampling events and this Supplemental RFI/RI. Sediment samples were gathered in association with the RFI/RI and the Supplemental RFI/RI. All the samples were collected from the western edge of the site along the shoreline. Metals were the most frequently detected contaminant, although in sediment several VOCs were detected as well. The distribution of the contaminants that exceeded ARARs and SALs is shown in Figure 4-29.

TABLE 4-68

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 3
NAS KEY WEST
PAGE 1 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S3SD-04	01/25/96	Aluminum	3,060	
S3SD-02	01/25/96	Aluminum	1,980	
S3SD-05	01/25/96	Aluminum	1,850	
S3DPSD-01	01/25/96	Aluminum	1,700	
S3SD-01	01/25/96	Aluminum	1,360	
S3SD-03	01/25/96	Aluminum	1,120	
S3SD-02	01/25/96	Arsenic	10.7	
S3DPSD-01	01/25/96	Arsenic	9.8	
S3SS-4	05/93	Arsenic	3.7	B
S3SS-1	05/93	Arsenic	2.7	
S3SS-3	05/93	Arsenic	1.7	B
S3SS-3	05/93	Arsenic	1.6	B
S3SS-2	05/93	Arsenic	1.3	B
S3SD-04	01/25/96	Barium	12.3	
S3SD-02	01/25/96	Barium	10.6	
S3SS-4	05/93	Barium	10.1	B
S3SD-05	01/25/96	Barium	8.9	
S3DPSD-01	01/25/96	Barium	8.7	
S3SD-03	01/25/96	Barium	8.7	
S3SD-01	01/25/96	Barium	7.9	
S3SS-3	05/93	Barium	7.1	B
S3SS-3	05/93	Barium	6.5	B
S3SS-1	05/93	Barium	5	B
S3SS-2	05/93	Barium	5	B
S3SD-04	01/25/96	Cadmium	1.1	
S3SD-02	01/25/96	Cadmium	0.92	
S3DPSD-01	01/25/96	Cadmium	0.83	
S3SD-03	01/25/96	Cadmium	0.65	
S3SD-01	01/25/96	Cadmium	0.62	
S3SD-05	01/25/96	Cadmium	0.41	
S3SD-01	01/25/96	Calcium	394,000	
S3SD-04	01/25/96	Calcium	379,000	
S3SD-03	01/25/96	Calcium	332,000	
S3SD-05	01/25/96	Calcium	319,000	
S3SD-02	01/25/96	Calcium	261,000	
S3DPSD-01	01/25/96	Calcium	236,000	
S3SS-4	05/93	Chromium	17.4	
S3SD-04	01/25/96	Chromium	13.7	
S3SS-3	05/93	Chromium	11.7	
S3SS-3	05/93	Chromium	10.1	
S3SD-02	01/25/96	Chromium	8.5	
S3SD-03	01/25/96	Chromium	8.1	
S3SS-2	05/93	Chromium	7.7	
S3SS-1	05/93	Chromium	7.2	
S3DPSD-01	01/25/96	Chromium	6.6	
S3SD-05	01/25/96	Chromium	5.6	
S3SD-01	01/25/96	Chromium	5.2	
S3SD-03	01/25/96	Cobalt	0.58	
S3SD-03	01/25/96	Copper	163	
S3SS-4	05/93	Copper	78.7	
S3SD-04	01/25/96	Copper	46.6	
S3SD-02	01/25/96	Copper	25	
S3DPSD-01	01/25/96	Copper	19.8	
S3SD-01	01/25/96	Copper	18.2	
S3SS-1	05/93	Copper	17.4	
S3SS-3	05/93	Copper	14.3	B
S3SS-3	05/93	Copper	12.7	B
S3SS-2	05/93	Copper	10.9	
S3SD-05	01/25/96	Copper	8.1	

TABLE 4-68

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 3
NAS KEY WEST
PAGE 2 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S3SS-2	05/93	Cyanide	14	
S3SD-05	01/25/96	Cyanide	1.8	J
S3SD-03	01/25/96	Iron	3,500	
S3SD-04	01/25/96	Iron	1,340	
S3SD-02	01/25/96	Iron	1,160	
S3DPSD-01	01/25/96	Iron	958	
S3SD-05	01/25/96	Iron	882	
S3SD-01	01/25/96	Iron	684	
S3SS-2	05/93	Lead	136	
S3SS-4	05/93	Lead	132	
S3SD-03	01/25/96	Lead	57	
S3SD-04	01/25/96	Lead	32.9	
S3SS-3	05/93	Lead	30.5	
S3SS-3	05/93	Lead	27.1	
S3SD-02	01/25/96	Lead	23.3	
S3DPSD-01	01/25/96	Lead	21.2	
S3SD-05	01/25/96	Lead	19.9	
S3SD-01	01/25/96	Lead	16.8	
S3SS-1	05/93	Lead	9.1	
S3SD-04	01/25/96	Magnesium	10,900	
S3SD-02	01/25/96	Magnesium	9,700	
S3DPSD-01	01/25/96	Magnesium	7,880	
S3SD-05	01/25/96	Magnesium	6,640	
S3SD-01	01/25/96	Magnesium	4,970	
S3SD-03	01/25/96	Magnesium	2,600	
S3SD-03	01/25/96	Manganese	22.3	
S3SD-02	01/25/96	Manganese	21.5	
S3SD-04	01/25/96	Manganese	17.6	
S3DPSD-01	01/25/96	Manganese	16.2	

Location	Date	Parameter	Result	Qual.(1)
S3SD-05	01/25/96	Manganese	10.5	
S3SD-01	01/25/96	Manganese	9.8	
S3SS-4	05/93	Mercury	0.14	
S3SS-1	05/93	Mercury	0.05	
S3SD-02	01/25/96	Nickel	2.9	
S3SD-04	01/25/96	Nickel	2.9	
S3SD-03	01/25/96	Nickel	2.5	
S3SD-01	01/25/96	Nickel	2.4	
S3DPSD-01	01/25/96	Nickel	2.2	
S3SD-05	01/25/96	Nickel	2.2	
S3SD-04	01/25/96	Potassium	1,700	
S3SD-02	01/25/96	Potassium	1,680	
S3DPSD-01	01/25/96	Potassium	1,360	
S3SD-01	01/25/96	Potassium	592	
S3SD-05	01/25/96	Potassium	528	
S3SD-03	01/25/96	Potassium	126	
S3SD-03	01/25/96	Silver	0.19	
S3SD-02	01/25/96	Sodium	23,800	
S3DPSD-01	01/25/96	Sodium	19,600	
S3SD-04	01/25/96	Sodium	15,900	
S3SD-01	01/25/96	Sodium	11,100	
S3SD-05	01/25/96	Sodium	3,980	
S3SD-03	01/25/96	Sodium	2,620	
S3SS-4	05/93	Sulfide	220	
S3SS-2	05/93	Sulfide	40	
S3SS-1	05/93	Tin	18.5	B
S3SD-04	01/25/96	Vanadium	9.4	
S3SS-4	05/93	Vanadium	7.5	B
S3SD-02	01/25/96	Vanadium	6	
S3DPSD-01	01/25/96	Vanadium	5.2	

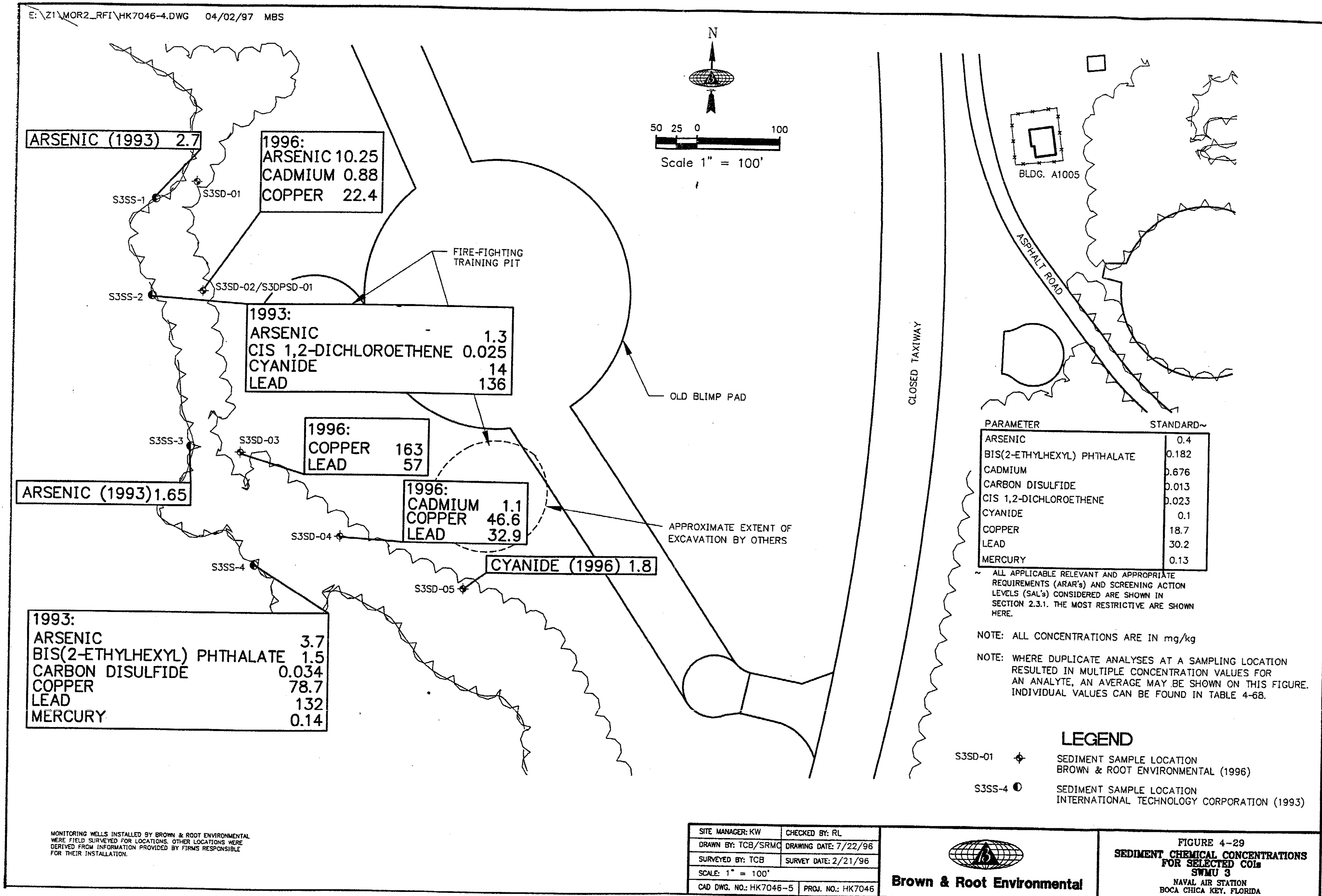
TABLE 4-68

CONTAMINANTS DETECTED IN SEDIMENT - SWMU 3
NAS KEY WEST
PAGE 3 OF 3

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (mg/kg) (cont.)				
S3SD-05	01/25/96	Vanadium	4.2	
S3SD-01	01/25/96	Vanadium	4.1	
S3SD-03	01/25/96	Vanadium	2.9	
S3SS-4	05/93	Zinc	88.9	
S3SD-03	01/25/96	Zinc	86.1	
S3SD-04	01/25/96	Zinc	69.2	
S3SD-02	01/25/96	Zinc	51.9	
S3SS-3	05/93	Zinc	45.8	
S3DPSD-01	01/25/96	Zinc	44.4	
S3SD-01	01/25/96	Zinc	37.1	
S3SS-2	05/93	Zinc	31.5	
S3SS-1	05/93	Zinc	29	
S3SD-05	01/25/96	Zinc	28.2	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
S3SS-4	05/93	Bis(2-ethylhexyl)phthalate	1,600	J
S3SS-4	05/93	Bis(2-ethylhexyl)phthalate	1,400	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S3SS-2	05/93	Acetone	23	J
S3SS-2	05/93	Acetone	11	J
S3SS-4	05/93	Carbon disulfide	34	
S3SS-2	05/93	Cis-1,2-dichloroethene	31	
S3SS-2	05/93	Cis-1,2-dichloroethene	19	
S3SS-4	05/93	Methacrylonitrile	2,700	D
S3SS-2	05/93	Methylene chloride	48	B
S3SS-4	05/93	Methylene chloride	38	B
S3SS-2	05/93	Methylene chloride	36	B

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-4).

1. Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, 3 of the 1995 BEI Delineation Study.


E:\Z1\MOR2_RFI\HK7046-4.DWG 04/02/97 MBS
N
50 25 0 100
Scale 1" = 100'
ARSENIC (1993) 2.7
1996:
ARSENIC 10.25
CADMIUM 0.88
COPPER 22.4
S3SS-1
S3SD-01
FIRE-FIGHTING TRAINING PIT
S3SD-02/S3DPSD-01
S3SS-2
1993:
ARSENIC 1.3
CIS 1,2-DICHLOROETHENE 0.025
CYANIDE 14
LEAD 136
OLD BLIMP PAD
CLOSED TAXIWAY
ASPHALT ROAD
BLDG. A1005
S3SS-3
S3SD-03
1996:
COPPER 163
LEAD 57
ARSENIC (1993) 1.65
1996:
CADMIUM 1.1
COPPER 46.6
LEAD 32.9
S3SD-04
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
S3SS-4
CYANIDE (1996) 1.8
S3SD-05
1993:
ARSENIC 3.7
BIS(2-ETHYLHEXYL) PHTHALATE 1.5
CARBON DISULFIDE 0.034
COPPER 78.7
LEAD 132
MERCURY 0.14
PARAMETER STANDARD~
ARSENIC 0.4
BIS(2-ETHYLHEXYL) PHTHALATE 0.182
CADMIUM 0.676
CARBON DISULFIDE 0.013
CIS 1,2-DICHLOROETHENE 0.023
CYANIDE 0.1
COPPER 18.7
LEAD 30.2
MERCURY 0.13
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN mg/kg
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-68.
LEGEND
S3SD-01 SEDIMENT SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
S3SS-4 SEDIMENT SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORPORATION (1993)
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: RL
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/22/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-5
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-29
SEDIMENT CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.3.5.2.1 Volatile Organic Compounds

Carbon disulfide and cis-1,2-DCE each exceeded the most restrictive sediment ARAR/SAL levels in a single sample. Carbon disulfide was found during the RFI/RI in the southernmost sample. At 0.034 mg/kg, the concentration was slightly less than three times the 0.013-mg/kg SAL. Cis-1,2-DCE was detected in the sample taken at S3SS-2. This concentration (0.025 mg/kg) was only slightly higher than the 0.023-mg/kg proposed RCRA Action Level. Several other VOCs were detected during the RFI/RI but did not approach the ARAR/SAL limits. No VOCs were detected during the Supplemental RFI/RI, which focused on sampling to the east of the RFI/RI sampling locations.

4.3.5.2.2 Semivolatile Organic Compounds

Bis(2-ethylhexyl)phthalate was the single SVOC to exceed ARAR/SAL sediment criteria at the Fire-Fighting Training Area. It was detected in a single sample from the RFI/RI. S3SS-4, the southernmost sampling location, contained 1.5 mg/kg of bis(2-ethylhexyl)phthalate. No SVOCs were detected in the other sediment samples at SWMU 3.

4.3.5.2.3 Pesticides

No pesticides were detected in sediment samples from the shoreline of the Fire-Fighting Training Area.

4.3.5.2.4 Polychlorinated Biphenyls

No PCBs were detected in the sediment at SWMU 3.

4.3.5.2.5 Metals and Inorganics

Arsenic, cadmium, cyanide, copper, and lead were all detected in excess of ARAR/SAL criteria in sediment samples from the Fire-Fighting Training Area. Arsenic, copper, cyanide, and lead were detected during both the RFI/RI and the Supplemental RFI/RI. Arsenic appears to be distributed along the shoreline, with the maximum value (10.25 mg/kg) occurring just west of the unexcavated training area. The maximum concentration of copper (163 mg/kg) was detected at S3SD-03, with decreasing amounts occurring both north and south of that point. The maximum cyanide concentration (14 mg/kg) occurred directly west of the unexcavated training pit, with a lower concentration detected to the south. Lead was detected at a maximum concentration of 136 mg/kg at S3SS-2, also west of the unexcavated pit, and at a comparable level in S3SS-4, to the south. Concentrations decreased between and beyond those two points. A small amount of mercury (0.14 mg/kg as compared to 0.13 mg/kg ARAR/SAL) was found along the southern part of the shoreline at S3SS-4. Cadmium was detected only during the Supplemental RFI/RI. The maximum cadmium level (1.1 mg/kg) was detected in sediment from S3SD-04 in the southwestern part of the site. Cadmium was also detected in the shoreline sample directly west of the unexcavated training pit.

4.3.5.3 Surface Water

Chemicals detected in surface water are listed in Table 4-69. Metals and inorganics were the only compounds that exceeded ARAR/SAL criteria in surface water at the site. With few exceptions, inorganic compounds were the only contaminants detected. Surface-water sampling was performed during the RFI/RI and the Supplemental RFI/RI.

To be conservative, FDEP Surface Water Criteria, EPA Surface Water Criteria, National Surface Water Criteria, and Region III Marine and Fresh Water Criteria were considered as ARARs/SALs. The most restrictive criteria were compared to each chemical concentration discussed in this section. The criteria considered are presented in Table 2-5. The distribution of chemicals in surface-water samples that exceeded the ARAR/SAL levels is shown in Figure 4-30.

4.3.5.3.1 Volatile Organic Compounds

Methylene chloride was detected in surface water at the Fire-Fighting Training Area in a single sample at a concentration of 1 μg/L, which is below the 5 μg/L proposed RCRA Action Level for water.

4.3.5.3.2 Semi-Volatile Organic Compounds

Only one SVOC was detected in surface water. Fluoranthene was identified during the RFI/RI in a surface-water sample from S3SS-3 at a concentration of 0.24 μg/L. This is insignificant compared to the 370-μg/L Surface Water Quality Criteria established for fluoranthene by FDEP.

4.3.5.3.3 Pesticides

No pesticides were detected in the surface water at SWMU 3.

TABLE 4-69

CONTAMINANTS DETECTED IN SURFACE WATER - SWMU 3
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (µg/L)				
S3SS-2	05/93	Antimony	111	
S3SS-3	05/93	Antimony	109	
S3SS-1	05/93	Antimony	100	
S3SS-3	05/93	Antimony	91.2	
S3SS-1	05/93	Barium	13	B
S3SW-03	1/25/96	Barium	8.9	
S3SS-2	05/93	Barium	8.4	B
S3SS-3	05/93	Barium	8.3	B
S3SW-05	1/25/96	Barium	8	J
S3SS-3	05/93	Barium	7.3	B
S3SW-04	1/25/96	Barium	7.2	
S3SW-01	1/25/96	Barium	6.9	
S3DPSW-01	1/25/96	Barium	6.9	
S3SW-02	1/25/96	Barium	6.7	
S3SW-01	1/25/96	Calcium	170,000	
S3SW-04	1/25/96	Calcium	153,000	
S3SW-05	1/25/96	Calcium	151,000	J
S3SW-03	1/25/96	Calcium	149,000	
S3DPSW-01	1/25/96	Calcium	143,000	
S3SW-02	1/25/96	Calcium	142,000	
S3SW-03	1/25/96	Copper	34.4	
S3SS-1	05/93	Copper	25.1	
S3SW-04	1/25/96	Copper	1.3	
S3SW-03	1/25/96	Cyanide	62.7	
S3SW-02	1/25/96	Cyanide	36.8	
S3SW-03	1/25/96	Iron	67.6	
S3SS-1	05/93	Lead	14.4	
S3SS-2	05/93	Lead	4.3	
S3SW-03	1/25/96	Magnesium	354,000	
S3SW-01	1/25/96	Magnesium	342,000	
S3SW-04	1/25/96	Magnesium	316,000	
S3SW-02	1/25/96	Magnesium	308,000	
S3DPSW-01	1/25/96	Magnesium	307,000	
S3SW-05	1/25/96	Magnesium	303,000	
S3SW-02	1/25/96	Nickel	2.2	
S3SW-03	1/25/96	Nickel	1.6	
S3SW-03	1/25/96	Potassium	119,000	
S3SW-04	1/25/96	Potassium	110,000	
S3SW-02	1/25/96	Potassium	109,000	
S3SW-01	1/25/96	Potassium	108,000	
S3DPSW-01	1/25/96	Potassium	105,000	
S3SW-05	1/25/96	Potassium	103,000	
S3SW-03	1/25/96	Sodium	3,270,000	
S3SW-04	1/25/96	Sodium	2,780,000	
S3SW-05	1/25/96	Sodium	2,770,000	
S3SW-01	1/25/96	Sodium	2,750,000	
S3DPSW-01	1/25/96	Sodium	2,740,000	
S3SW-02	1/25/96	Sodium	2,690,000	
S3SW-02	1/25/96	Thallium	8.5	
S3SW-04	1/25/96	Thallium	7.1	
S3SW-03	1/25/96	Thallium	6.5	
S3SW-05	1/25/96	Thallium	4.8	J
S3SS-2	05/93	Thallium	4.3	B
S3SS-3	05/93	Thallium	3.3	B
S3SS-3	05/93	Tin	126	B
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)				
S3SS-3	05/93	Fluoranthene	0.24	

TABLE 4-69

CONTAMINANTS DETECTED IN SURFACE WATER - SWMU 3
NAS KEY WEST
PAGE 2 OF 2

Location	Date	Parameter	Result	Qual.[1]
VOLATILE ORGANIC COMPOUNDS (µg/L)				
S3SS-2	05/93	Methylene chloride	1	JB

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-5).

1. Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, 3 of the 1995 BEI Delineation Study.

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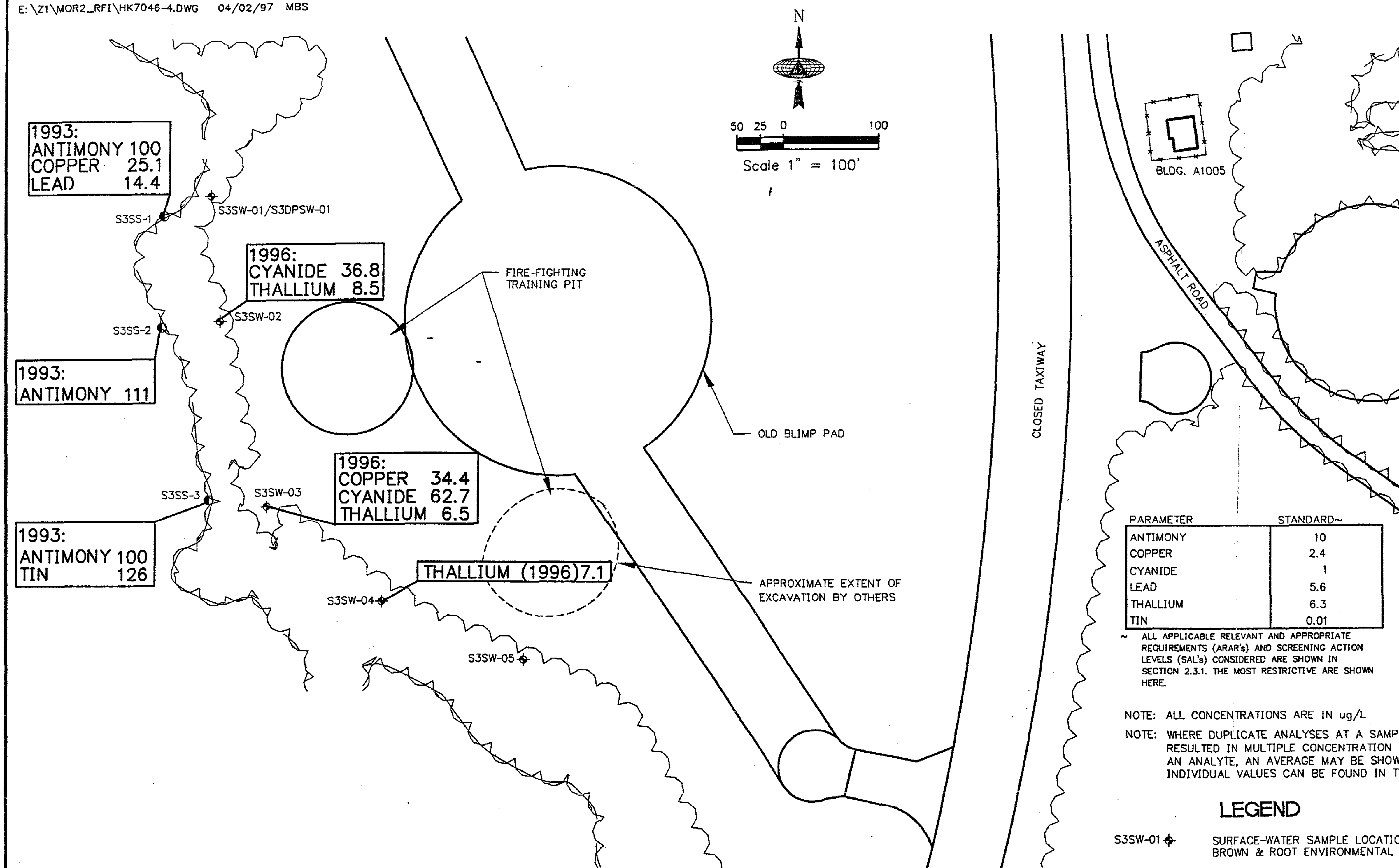


PARAMETER	STANDARD~
ANTIMONY	10
COPPER	2.4
CYANIDE	1
LEAD	5.6
THALLIUM	6.3
TIN	0.01

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-69.

LEGEND

S3SW-01 SURFACE-WATER SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

S3SS-4 SURFACE-WATER SAMPLE LOCATION INTERNATIONAL TECHNOLOGY CORPORATION (1993)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: RL
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/22/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-30
SURFACE-WATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

0000F157

4.3.5.3.4 Polychlorinated Biphenyls

No PCBs were detected in the surface water at SWMU 3.

4.3.5.3.5 Metals and Inorganics

Antimony, copper, cyanide, lead, thallium, and tin were all identified in excess of ARAR/SAL criteria in surface-water samples from the Fire-Fighting Training Area. Antimony, lead, and tin were found only in samples from the RFI/RI. Lead (14.4 µg/L) and tin (126 µg/L) each exceeded ARAR/SAL levels at a single location, while antimony exceeded its 10-µg/L proposed RCRA Action Level at all three RFI/RI sampling locations. The antimony concentration appeared to be fairly consistent from sample to sample, around 100 µg/L. Copper was found in the sample from the northernmost RFI/RI location at 25.1 µg/L and also exceeded the 2.4-µg/L National Surface Water Criteria in the 1996 sample from S3SW-03. Thallium was the contaminant most consistently found during the Supplemental RFI/RI. It was detected at four of the five Supplemental RFI/RI sampling locations, and was slightly in excess of the 6.3 µg/L FDEP Surface Water Quality Criteria at three of these points. The maximum detection was 8.5 µg/L which is close to the FDEP limit. Cyanide was seen in two of the Supplemental RFI/RI surface-water samples. It exceeded the 1-µg/L FDEP Surface Water Quality Criteria at both these locations, with a maximum value of 62.7 µg/L at S3SW-03.

4.3.5.4 Groundwater

Chemicals detected in groundwater are listed in Table 4-70. The distribution of contaminants defined by the three previous investigations and the Supplemental RFI/RI is shown in Figures 4-31 through 4-33. The data from each sampling effort is shown in a separate figure with the exception of the initial investigation performed in 1986. No figure is associated with the initial investigation data because no contaminant levels were detected above ARAR/SAL levels. Groundwater contamination is due primarily to two classes of compounds: VOCs and SVOCs.

Although the groundwater underlying the site is designated G-III (nonpotable), SDWA MCLs, Florida MCLs, FDEP Guidance Concentrations, and RCRA Action Levels were all considered as ARARs/SALs to be conservative. The most restrictive criteria were used in evaluating the nature and extent of groundwater contamination in this section, and those criteria are shown in Table 2-6.

TABLE 4-70

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 3
NAS KEY WEST
PAGE 1 OF 3

Location	Date	Parameter	Result	Qual.[1]
INORGANICS (µg/L)				
MW10-3	05/90	Aluminum	12,300	
MW10-2	05/90	Aluminum	11,500	
KWM-19	05/90	Aluminum	2,590	
KWM-18	05/90	Aluminum	67.1	B
MW10-3	05/93	Antimony	161	
S3MW-1	05/93	Antimony	152	
KWM-18	05/90	Antimony	137	
S3MW-5	05/93	Antimony	126	
S3MW-4	05/93	Antimony	123	
S3MW-2	05/93	Antimony	82.5	
MW10-1	05/93	Antimony	71.9	
MW10-1	05/90	Arsenic	39.3	
MW10-3	05/93	Arsenic	35.1	
S3MW-2	05/93	Arsenic	27.4	
MW10-1	05/93	Arsenic	19.6	B
S3MW-4	05/93	Arsenic	12.9	
KWM-18	05/90	Arsenic	12.2	
S3MW-1	05/93	Arsenic	6	B
S3MW-5	05/93	Arsenic	4.2	B
MW10-2	05/90	Barium	226	
S3MW-5	05/93	Barium	42.4	B
MW10-1	05/90	Barium	41.2	B
S3MW-4	05/93	Barium	37.4	B
S3MW-1	05/93	Barium	28.3	B
S3MW-2	05/93	Barium	25.8	B
MW10-3	05/93	Barium	16.6	B
MW10-1	05/93	Barium	11.8	B
KWM-18	05/90	Barium	10.4	B
MW10-2	05/90	Calcium	12,700,000	
MW10-3	05/90	Calcium	10,200,000	
KWM-19	05/90	Calcium	4,920,000	
KWM-18	05/90	Calcium	229,000	
MW10-2	05/90	Chromium	73.5	
MW10-3	05/90	Chromium	53	
KWM-19	05/90	Chromium	25	
S3MW-5	05/93	Chromium	17.3	
MW10-1	05/90	Chromium	17	
S3MW-4	05/93	Chromium	15.9	
S3MW-2	05/93	Chromium	13.8	
MW10-1	05/93	Chromium	10.1	
KWM-19	05/90	Copper	91.9	
MW10-1	05/90	Copper	38.6	
MW10-3	05/90	Copper	30.1	
MW10-1	05/93	Copper	15.4	B
KWM-18	05/90	Copper	10.4	B
MW10-3	05/90	Iron	4,940	
MW10-2	05/90	Iron	2,490	
KWM-19	05/90	Iron	2,210	
KWM-18	05/90	Iron	1,230	
MW10-3	05/90	Magnesium	1,180,000	
KWM-19	05/90	Magnesium	848,000	
MW10-2	05/90	Magnesium	651,000	
KWM-18	05/90	Magnesium	152,000	
MW10-3	05/90	Manganese	62.2	
MW10-2	05/90	Manganese	42.4	
KWM-19	05/90	Mercury	0.39	
MW10-3	05/90	Mercury	0.26	

TABLE 4-70

CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 3
NAS KEY WEST
PAGE 2 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (µg/L) (cont.)				
S3MW-5	05/93	Mercury	0.23	
MW10-3	05/90	Potassium	343,000	
KWM-19	05/90	Potassium	256,000	
MW10-2	05/90	Potassium	196,000	
KWM-18	05/90	Potassium	70,900	
MW10-1	05/90	Silver	22.6	
MW10-3	05/90	Sodium	9,340,000	
KWM-19	05/90	Sodium	7,180,000	
MW10-2	05/90	Sodium	5,300,000	
KWM-18	05/90	Sodium	1,330,000	
MW10-1	05/93	Sulfide	54,000	
S3MW-2	05/93	Sulfide	15,000	
MW10-1	05/90	Sulfide	2,000	
MW10-1	05/93	Tin	73.6	B
MW10-2	05/90	Vanadium	58.1	
MW10-1	05/90	Vanadium	14.8	B
KWM-18	05/90	Zinc	45.5	
KWM-19	05/90	Zinc	32.6	
MW10-1	05/90	Zinc	25.3	
S3MW-4	05/93	Zinc	14	B
S3MW-5	05/93	Zinc	13.3	B
MW10-1	05/93	Zinc	6.4	B
S3MW-2	05/93	Zinc	5.9	B
PESTICIDES/PCBs (µg/L)				
MW10-1	05/90	Aldrin	0.11	Z
MW10-1	05/90	Alpha-BHC	0.35	Z
MW10-1	05/90	Beta-BHC	1	Z
MW10-1	05/90	Delta-BHC	0.3	Z
MW10-1	05/90	Gamma-BHC (lindane)	0.75	Z
MW10-1	05/90	Heptachlor	0.42	Z
MISCELLANEOUS ANALYSES (mg/L)				
KWM-19	07/86	Total dissolved solids	38,000	
KWM-18	07/86	Total dissolved solids	2,200	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)				
S3MW-2	05/93	1-methylnaphthalene	33	Y
S3MW-2	05/93	2,4-dimethylphenol	43	
S3MW-2	02/01/96	2-methylnaphthalene	67	
S3MW-2	05/93	2-methylnaphthalene	17	
S3MW-8	02/01/96	2-methylnaphthalene	11	
KMW-18	05/90	2-methylnaphthalene	10	J
S3MW-2	02/01/96	Naphthalene	114	
S3MW-2	05/93	Naphthalene	40	
KWM-18	05/90	Naphthalene	39	
S3MW-8	02/01/96	Naphthalene	19	
S3MW-4	05/93	Naphthalene	15	
KWM-18	05/93	Naphthalene	4.5	
VOLATILE ORGANIC COMPOUNDS (µg/L)				
S3MW-2	05/93	1,1-dichloroethane	19	
KWM-18	05/90	1,1-dichloroethane	2	J
KWM-18	05/90	1,1-dichloroethene	3.1	
S3MW-8	02/01/96	4-methyl-2-pentanone	3	J
MW10-2	05/90	Acetone	46	
KMW-19	05/90	Acetone	9	J
MW10-1	05/93	Acetone	7	J
KMW-18	05/90	Acetone	3	BJ
S3MW-2	05/93	Acetone	3	J
KWM-18	05/90	Benzene	11	

TABLE 4-70

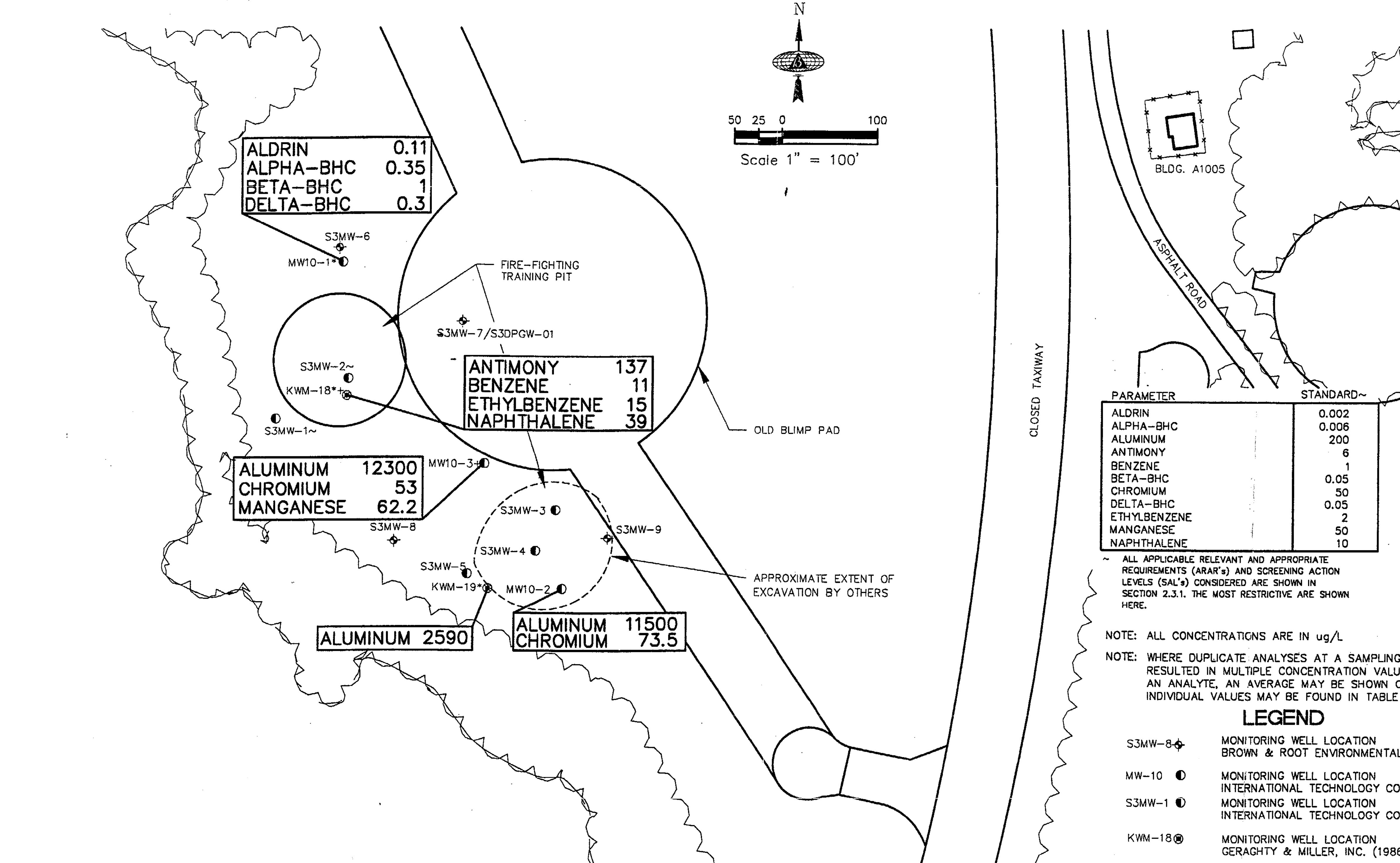
CONTAMINANTS DETECTED IN GROUNDWATER - SWMU 3
NAS KEY WEST
PAGE 3 OF 3

Location	Date	Parameter	Result	Qual.[1]
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S3MW-2	05/93	Benzene	4	J
S3MW-6	02/01/96	Bromomethane	3	
S3MW-1	02/01/96	Carbon disulfide	12	
MW10-2	05/90	Carbon disulfide	4	BJ
MW10-3	05/90	Carbon disulfide	4	BJ
KWM-19	05/90	Carbon disulfide	3	BJ
MW10-1	05/93	Carbon disulfide	3	J
S3MW-2	05/93	Carbon disulfide	3	J
S3MW-8	02/01/96	Carbon disulfide	2	J
KWM-18	05/90	Chloroethane	1	J
S3MW-1	05/93	Cis-1,2-dichloroethene	3.7	
MW10-1	05/93	Cis-1,2-dichloroethene	3	J
KWM-18	05/90	Ethylbenzene	15	
S3MW-2	05/93	Ethylbenzene	11	
S3MW-2	02/01/96	Ethylbenzene	9	J
S3MW-8	02/01/96	Ethylbenzene	5	
S3MW-6	02/01/96	Iodomethane	6	
KWM-18	07/86	Methylene chloride	5	
S3MW-2	05/93	Methylene chloride	3	BJ
KMW-19	05/90	Methylene chloride	2	BJ
MW10-2	05/90	Methylene chloride	2	BJ
MW10-1	05/93	Methylene chloride	2	BJ
MW10-3	05/90	Methylene chloride	2	BJ
S3MW-2	05/93	Toluene	2	J
KWM-18	05/90	Toluene	1	J
S3MW-1	05/93	Trans-1,2-dichloroethene	6	
S3MW-8	02/01/96	Vinyl acetate	3	J
MW10-1	05/93	Vinyl chloride	17	
S3MW-1	05/93	Vinyl chloride	7.1	
KWM-18	05/90	Xylenes (total)	17	
S3MW-2	02/01/96	Xylenes (total)	9	J
S3MW-4	05/93	Xylenes (total)	5.3	
S3MW-2	05/93	Xylenes (total)	5	J
S3MW-1	02/01/96	Xylenes (total)	2	
S3MW-8	02/01/96	Xylenes (total)	2	
S3MW-6	02/01/96	Xylenes (total)	1	J

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-6).

1. Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, 3 of the 1995 BEI Delineation Study.

E: \Z1\MOR2_RFI\HK7046-5.DWG 06/30/97 MBS



PARAMETER	STANDARD~
ALDRIN	0.002
ALPHA-BHC	0.006
ALUMINUM	200
ANTIMONY	6
BENZENE	1
BETA-BHC	0.05
CHROMIUM	50
DELTA-BHC	0.05
ETHYLBENZENE	2
MANGANESE	50
NAPHTHALENE	10

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-70.

LEGEND

S3MW-8 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MW-10 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)

S3MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)

KWM-18 — MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)

* ALSO SAMPLED BY IT IN 1990

+ ALSO SAMPLED BY IT IN 1993

~ ALSO SAMPLED BY B&RE IN 1996

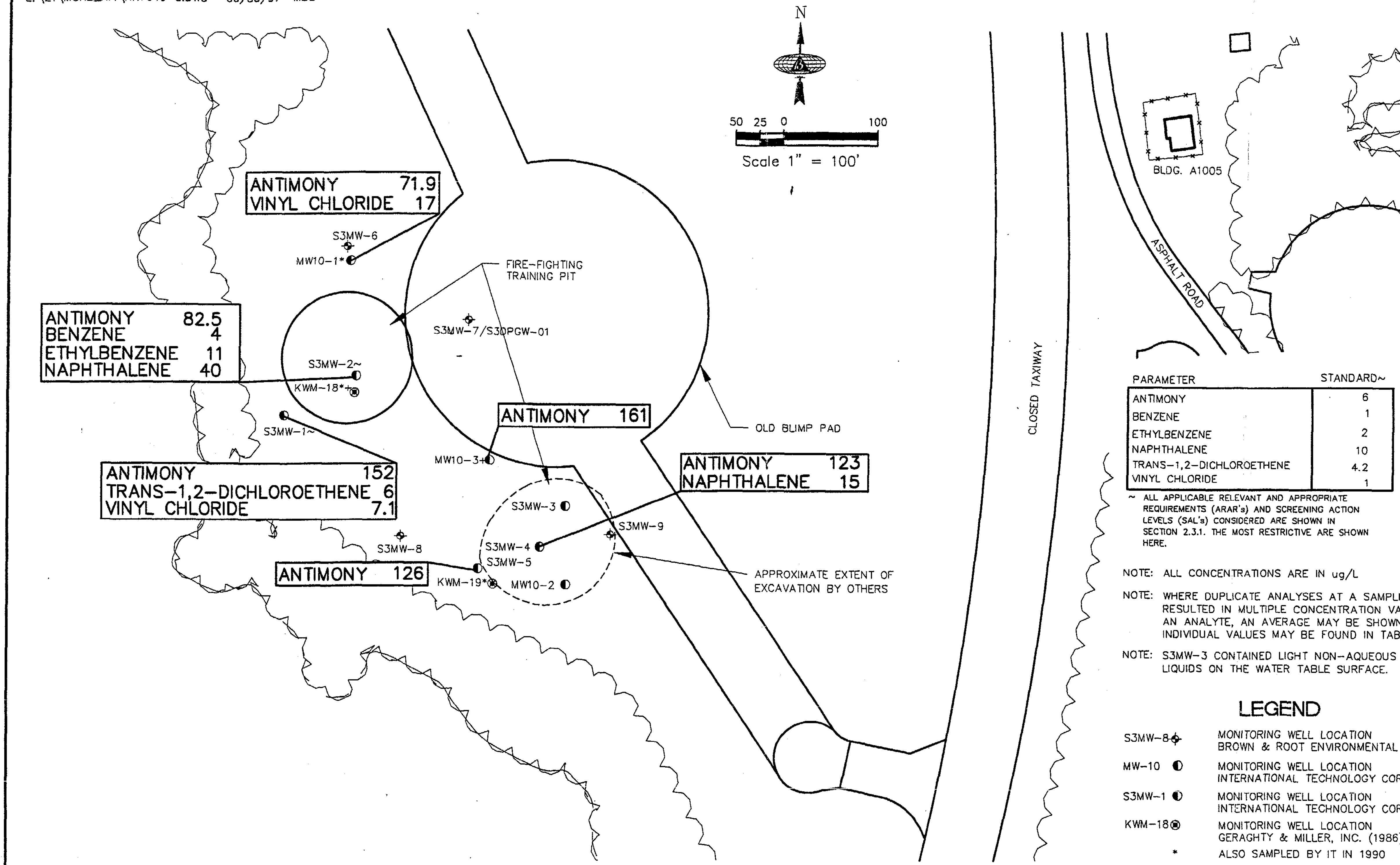
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: RL
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/22/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-31
1990 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

E:\Z1\MOR2_RFI\HK7046-5.DWG 06/30/97 MBS



PARAMETER	STANDARD~
ANTIMONY	6
BENZENE	1
ETHYLBENZENE	2
NAPHTHALENE	10
TRANS-1,2-DICHLOROETHENE	4.2
VINYL CHLORIDE	1

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN ug/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-70.

NOTE: S3MW-3 CONTAINED LIGHT NON-AQUEOUS PHASE LIQUIDS ON THE WATER TABLE SURFACE.

LEGEND

S3MW-8 — MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MW-10 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)

S3MW-1 — MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)

KWM-18 — MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)

* ALSO SAMPLED BY IT IN 1990

+ ALSO SAMPLED BY IT IN 1993

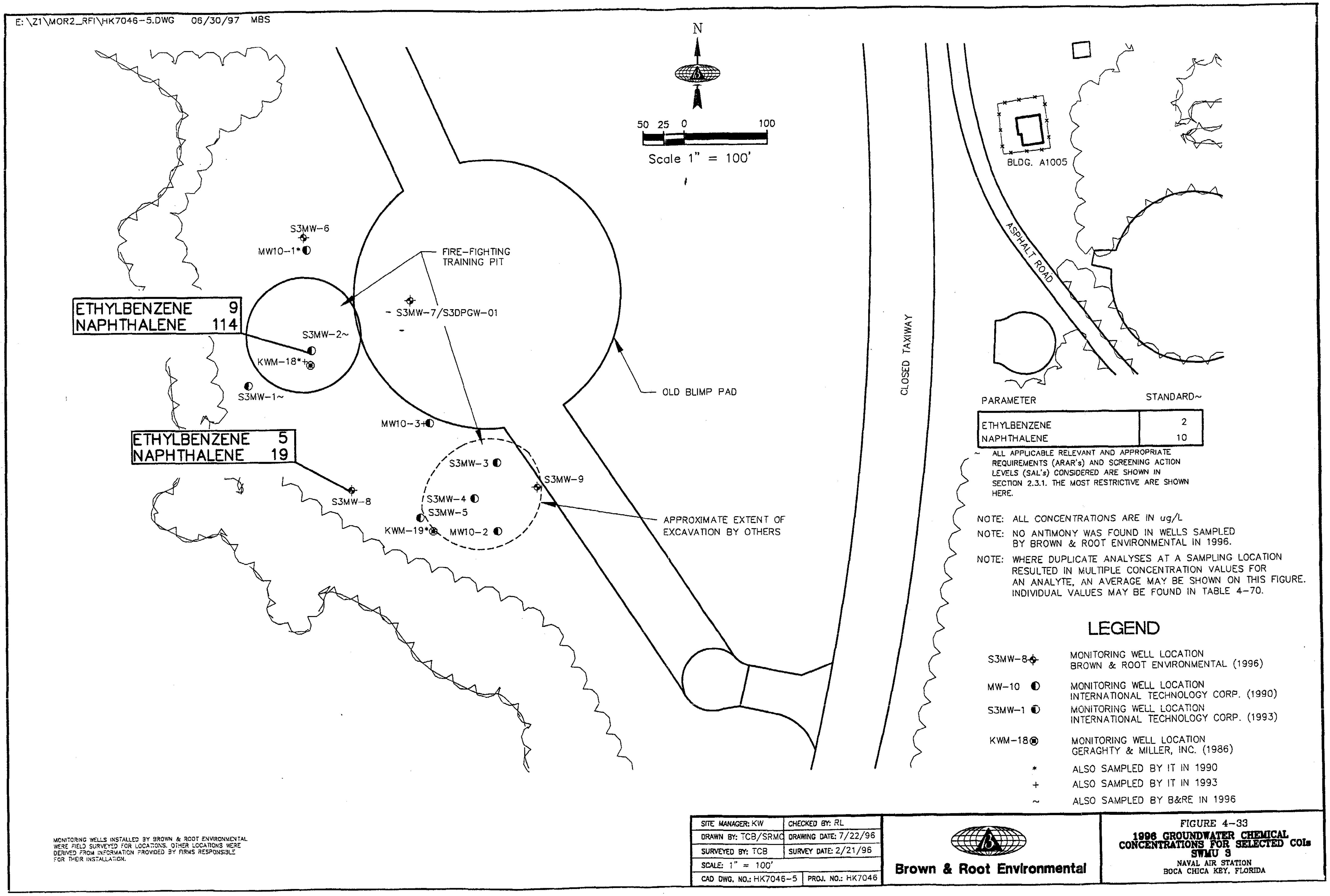
~ ALSO SAMPLED BY B&RE IN 1996

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: RL
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/22/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 100'	
CAD DWG. NO.: HK7046-5	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-32
1993 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA


E:\Z1\MOR2_RFI\HK7046-5.DWG 06/30/97 MBS
N
50 25 0 100
Scale 1" = 100'
S3MW-6
MW10-1*
FIRE-FIGHTING TRAINING PIT
ETHYLBENZENE 9
NAPHTHALENE 114
S3MW-7/S3DPGW-01
S3MW-2~
KWM-18*+
S3MW-1~
OLD BLIMP PAD
CLOSED TAXIWAY
BLDG. A1005
ASPHALT ROAD
MW10-3+
ETHYLBENZENE 5
NAPHTHALENE 19
S3MW-3
S3MW-9
S3MW-4
S3MW-5
S3MW-8
KWM-19*
MW10-2
APPROXIMATE EXTENT OF EXCAVATION BY OTHERS
PARAMETER
STANDARD~
ETHYLBENZENE 2
NAPHTHALENE 10
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN ug/L
NOTE: NO ANTIMONY WAS FOUND IN WELLS SAMPLED BY BROWN & ROOT ENVIRONMENTAL IN 1996.
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES MAY BE FOUND IN TABLE 4-70.
LEGEND
S3MW-8 MONITORING WELL LOCATION BROWN & ROOT ENVIRONMENTAL (1996)
MW-10 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1990)
S3MW-1 MONITORING WELL LOCATION INTERNATIONAL TECHNOLOGY CORP. (1993)
KWM-18 MONITORING WELL LOCATION GERAGHTY & MILLER, INC. (1986)
* ALSO SAMPLED BY IT IN 1990
+ ALSO SAMPLED BY IT IN 1993
~ ALSO SAMPLED BY B&RE IN 1996
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: RL
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/22/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 100'
CAD DWG. NO.: HK7046-5
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-33
1996 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 3
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.3.5.4.1 Volatile Organic Compounds

Initial investigation sampling included two wells, which contained one VOC (methylene chloride) at a concentration equal to its 5 µg/L-proposed RCRA Action Level. In other investigations at the site, methylene chloride was not detected at or above this level. Between 1990 and 1996, benzene, ethylbenzene, trans-1,2-dichloroethene, and vinyl chloride were detected in groundwater samples at levels above the most restrictive ARAR/SAL limits. VOCs were consistently detected in the area of the unexcavated training pit, with benzene and ethylbenzene present at decreasing levels over time. Low levels of trans-1,2-dichloroethene and vinyl chloride were detected only in the RFI/RI. Ethylbenzene was the only VOC in excess of ARAR/SAL criteria during the Supplemental RFI/RI, although levels were reduced from those detected during previous investigations. Acetone, 1,1-DCA, 1,1-DCE, 4-methyl-2-pentanone, bromomethane, carbon disulfide, chloroethane, cis-1,2-DCE, iodomethane, toluene, vinyl acetate, and xylene were all detected in groundwater at SWMU 3, but none were above their respective ARAR/SAL levels.

4.3.5.4.2 Semivolatile Organic Compounds

Naphthalene was detected in excess of its 10-µg/L FDEP Guidance Concentration. It has been found in increasing levels from 1990 through 1996. The maximum level (114 µg/L) was detected during the Supplemental RFI/RI in the vicinity of the unexcavated training pit. A lower concentration was also found in a well toward the south during the Supplemental RFI/RI.

No other SVOCs were detected in excess of available ARAR/SAL criteria. Other SVOCs detected at low levels during previous investigations include 1-methylnaphthalene, 2,4-dimethylphenol, and 2-methylnaphthalene. Most of these compounds were found in S3MW-2, which is located in the unexcavated training pit.

4.3.5.4.3 Pesticides

Pesticides were only detected in one well (MW10-1) during one investigation (the Preliminary RI). Aldrin (0.11 µg/L), alpha-BHC (0.35 µg/L), beta-BHC (1 µg/L), and delta-BHC (0.3 µg/L) were detected at levels above the most restrictive ARAR/SAL limits. Gamma-BHC and heptachlor were detected at levels below the most restrictive ARAR/SAL criteria.

No pesticides were detected during any previous or subsequent investigation.

4.3.5.4.4 Polychlorinated Biphenyls

No PCBs were detected in the groundwater at SWMU 3.

4.3.5.4.5 Metals and Inorganics

Aluminum, chromium, and manganese were detected in excess of ARAR/SAL criteria during the Preliminary RI in the vicinity of the southern training pit, which was later excavated. Aluminum was the most frequently detected metal at this location. In the samples collected during the RFI/RI, antimony was the only inorganic that was significant when compared to ARARs and SALs.

4.3.5.5 Summary of Contaminant Release

The introduction of contaminants into the environment at SWMU-3 can be attributed to the fire training activities conducted by base personnel at the site. Petroleum hydrocarbon fuels, waste oil, and solvents were all burned at the site. Thus, VOCs and SVOCs are the dominant groundwater contaminants. While these compounds were detected at some level in the other media, they were not detected above their ARAR/SAL levels during the Supplemental RFI/RI. Metals and inorganics were the most common class of contaminants detected throughout the other media at the site.

VOCs including benzene, ethylbenzene, trans-1,2-dichloroethene, and vinyl chloride were consistently detected in groundwater underlying the unexcavated training pit during previous investigations; however, ethylbenzene (9 µg/L) was the only VOC detected in excess of ARAR/SAL criteria during the Supplemental RFI/RI. Naphthalene was detected in groundwater in increasing concentrations from 1990 to 1996. The maximum value of naphthalene (114 µg/L) was found directly under the unexcavated training pit during the Supplemental RFI/RI. Chromium and manganese were both found to exceed ARAR/SAL levels during the Preliminary RI but were not identified as significant contaminants in subsequent investigations. Antimony appeared to be a common groundwater contaminant in the RFI/RI but was not detected at the site in the other investigations.

Metals were predominantly detected in soil and sediment. Arsenic and chromium were detected consistently in soil from the perimeter of the excavated training pit at maximum concentrations of 0.68 mg/kg and 3 mg/kg, respectively. Chromium was also detected in both surface and subsurface samples from the unexcavated pit. The surface sample was comparable to that seen at the excavated pit, with a slightly higher subsurface concentration of 3.6 mg/kg. Arsenic levels in sediment were much higher than those observed in soil, with a maximum of 10.25 mg/kg found directly west of the unexcavated pit.

Copper and lead were detected consistently in sediment; cyanide exceeded its 0.1 mg/kg-SAL in only two sediment samples. Mercury and cadmium were detected in a single sample each. VOCs and SVOCs were detected in excess of ARAR/SAL levels in only two sediment samples. S3SS-2 (located due west of the unexcavated training pit) contained 0.031 mg/kg of cis-1,2-DCE in 1994. S3SS-4, west of the excavated training pit, contained bis(2-ethylhexyl)phthalate (1.5 mg/kg) and carbon disulfide (0.035 mg/kg). Neither of the Supplemental RFI/RI samples, taken slightly to the east of these locations, contained significant amounts of VOCs or SVOCs.

Antimony and thallium were assumed to be common surface-water contaminants based on results from previous investigations; however, antimony was detected only during the RFI/RI. Thallium was detected during the Supplemental RFI/RI at levels slightly in excess of the 6.3-μg/L limit and during the RFI/RI at lower levels. Copper was detected in excess of its ARAR/SAL level in isolated samples from the RFI/RI and the Supplemental RFI/RI. No pattern of copper as a surface-water contaminant is apparent from these results. Lead and tin were each detected in isolated samples during the RFI/RI and were not detected during the Supplemental RFI/RI. Cyanide was detected above its ARAR/SAL level twice during the Supplemental RFI/RI, once at 62.7 μg/L and once at 36.8 μg/L, compared to a 1-μg/L FDEP Surface Water Quality Criterion.

4.3.6 Contaminant Fate and Transport

The behavior of contaminants in the environment at SWMU 3 is described in this section. Various chemicals detected and their transport potential in the environment are discussed in Section 4.3.6.1. Persistence of detected chemicals in the environment is discussed in Section 4.3.6.2. Section 4.3.6.3 discusses contaminant trends. Chemical and physical properties of COPCs detected at SWMU 3 are presented in Appendix G.

4.3.6.1 Detected Chemicals and Transport Potential

Analytical results for the media sampled at SWMU 3 indicate halogenated and aromatic VOCs, carbon disulfide, ketones, light molecular weight PAHs, and methylphenol are present in groundwater. Aromatic VOCs, acetone, methylene chloride, and phthalate esters were detected in surface or subsurface soils. Halogenated VOCs, carbon disulfide, acetone, and a phthalate ester were detected in sediment samples. Fluoranthene was detected in a surface water sample. Inorganics were detected in sediment, groundwater, soil, and surface water samples, in some cases above background levels.

Of the detected groundwater contaminants, the VOCs and phenol are typically considered highly mobile and water-soluble, with the solubility and mobility of naphthalene and 2-methylnaphthalene considered moderate but lower than VOCs.

Several groundwater contaminants (1,1-DCE, 1,2-DCE, and vinyl chloride) are associated with degradation of PCE and TCE (or in the case of 1,1-DCA, degradation of 1,1,1-trichloroethane), and may be the result of the decomposition of the latter in groundwater (Cline and Vista, 1983). Halogenated VOCs present in groundwater were found at low-ppb levels and were either not detected in other SWMU 3 media (surface water, soil, or sediment) or were detected in these media only at low ppb levels. Therefore, VOC source areas at SWMU 3 may have been depleted of halogenated VOCs through gradual migration or degradation. Aromatic VOCs were also detected in groundwater at low levels in the north burn area. It is not known whether significant sources of contamination remain, because only one soil sample has been collected at the north burn area and this sample revealed only low levels of aromatic VOCs.

Lead was detected at slightly elevated levels (100 ppm range) in two sediment samples collected along the lagoon shoreline during a previous investigation. The transport of lead in the aquatic environment is influenced by the speciation of the ion. Sorption processes appear to exert a dominant effect on the distribution of lead in the environment. Adsorption to inorganic solids, organic materials, and hydrous iron and manganese oxides usually controls the mobility of lead and results in a strong partitioning of lead to the bed sediments in aquatic systems. The sorption mechanism most important in a particular system varies with geological setting, pH, Eh, availability of ligands, dissolved and particulate concentrations, and chemical composition. Lead is strongly complexed to organic materials present in aquatic systems and soil (Clement Associates, 1985).

4.3.6.2 Persistence

For the classes of detected chemicals, environmental persistence varies considerably. Transformation of a chemical to degradation by-products can be the result of numerous processes including biotransformation and uptake, photolysis, acid- or base-catalyzed reaction, or hydrolysis. The product chemicals may or may not be significantly different from a toxicological or a physical transport perspective. If the transformational process is known or suspected, product chemicals can be predicted and extent of transformation can be determined from chemical reaction rate data. Other transformational processes may be identified empirically from analytical data.

Although most chemicals are resistant to chemical change because of their stability or lack of reaction sites, many of the more mobile species are subjected to at least limited transformation. Because of more frequent contact with reactive dissolved species and catalysts when compared to unsaturated conditions, the contaminants found in saturated media (groundwater and saturated zone soils) are most likely to be transformed in the environment. Higher molecular weight contaminants tend to be less mobile and less prone to chemical transformation.

1,2-DCE, 1,1-DCE, and 1,1-DCA, and vinyl chloride, which are considered byproducts of the degradation of TCE, PCE, or 1,1,1-trichloroethane (TCA), can further degrade to lesser-chlorinated species. In addition, the low persistence of these compounds in soil is influenced by their solubility and high volatility.

Inorganic compounds have a strong tendency to adsorb onto soil and sediment particles, a factor that greatly reduces their mobility. Many metals are water-insoluble; however, some soluble species of metals have increased mobility.

4.3.6.3 Observed Chemical Contaminant Trends

Low levels of aromatic volatiles and naphthalenes detected in monitoring wells are the result of migration of petroleum fuels from the fire training areas. The burn area to the south of the old blimp pad has undergone a removal action. Several months after the removal was completed, naphthalene and 2-methyl naphthalene were detected in a monitoring well adjacent to the south burn area, which indicates that some residual contamination exists. Because of source removal, these low residual levels of contaminants are likely to decrease over time as soil and groundwater contamination are further attenuated by natural degradation and dilution processes.

At the north burn area, no removal has been conducted, and data are inadequate to determine whether significant sources of aromatic VOCs and naphthalenes still remain in subsurface soil. Several rounds of groundwater sampling have revealed naphthalene levels to be somewhat consistent over time, although VOCs have diminished in concentration. Benzene and chlorinated ethenes were not detected in the latest round of sampling and the levels of xylenes continuously decreased between 1990 and 1996. This trend is consistent with the more mobile and less persistent quality of VOCs relative to other groundwater contaminants.

Although several metals were detected at levels somewhat greater than background, the occurrence and frequency of low-level metals contamination was different in each medium. Therefore, no obvious pattern of contaminant migration is suggested for most metals. Since lead was not found at significant levels in soils collected within the burn areas or in additional samples collected west and south of these area, this indicates that the occurrence of lead at slightly elevated levels in two shoreline sediment locations does not appear to have been caused by overland migration of lead from fire training areas. Antimony, which was found in groundwater and surface water, and thallium, which was detected during one round of surface-water sampling, also were not found at elevated levels in soils at SWMU 3. Neither of these metals would be expected to be associated with fire training activities.

Antimony was detected at elevated levels (100 ppb range) in site-related and background surface water samples and in site-related groundwater samples collected during an earlier investigation but was not found in groundwater samples at relatively low detection limits in the most recent round of sampling. Since antimony is not normally found in seawater at levels near this concentration range, this suggests that earlier antimony data may not be as trustworthy as recent results, conceivably because of analysis interferences or sensitivity prohibits problems associated with earlier sampling rounds.

Several organic substances were detected that are considered common or ubiquitous laboratory contaminants. Despite the use of proper sampling protocols and data validation to minimize analytical bias, methylene chloride, acetone, and bis(2-ethylhexyl)phthalate remained after data validation in both site and background data sets. Given the sporadic nature of their detection, this does not suggest any pattern of contamination related to SWMU 3 activities for these substances.

Bromomethane, iodomethane, and vinyl acetate were not found in background samples and were each detected in only one sample from a given sampling medium. For these substances, which are rarely encountered at waste sites, the relative significance of a single detection at levels below or near quantitation limits is unclear, because they were not detected elsewhere in site-related samples and are not related to known previous site activities. Based upon limited detections, it is not safe to conclude that there is a potential for widespread contamination for these compounds at SWMU 3.

Methacrylonitrile is another uncommon substance that does not appear to be associated with fire training activities and was also detected in only one sample. The reported result of 2,700 µg/kg in a sediment sample (S3SS-4) does not appear reliable because of serious disagreement with the field duplicate of this sample, which revealed a not detected value at a much lower detection limit (50 µg/kg).

4.3.7 Baseline Human Health Risk Assessment

This section presents the baseline HHRA for SWMU 3. It discusses the preliminary risk evaluation, data evaluation, toxicity assessment, exposure assessment, risk characterization, and remedial goal options. Conclusions about the baseline HHRA are presented in Section 4.3.7.8. The baseline HHRA presented in this section is a qualitative and quantitative assessment of actual or potential risks for SWMU 3. The methodologies and techniques used in the assessment are outlined in Section 3.2 of Appendix G.

4.3.7.1 Preliminary Risk Evaluation

Tables 4-71 and 4-72 summarize the preliminary risk evaluations for SWMU 3 for carcinogenic and noncarcinogenic risks, respectively. The risk ratio calculated assuming an industrial land use scenario is less than 1E-04 and 1.0 for carcinogenic and noncarcinogenic effects, respectively. The risk ratio calculated assuming a residential land use scenario is less than 1E-04 for carcinogenic effects (Table 4-71). However, the risk ratio calculated assuming a residential land use scenario is greater than 1.0 for noncarcinogenic effects (Table 4-72). Thus, a baseline human health risk assessment is necessary for SWMU 3. The preliminary contributors to the noncarcinogenic HI exceeding 1.0 are antimony and thallium in surface water. Appendix G, Section 3.2.1 contains the methods used for preliminary risk assessment analysis.

4.3.7.2 Data Evaluation

A list of COPCs was developed for each environmental medium, as necessary. Only those chemicals selected as COPCs were considered for evaluation in the quantitative risk assessment. A discussion of those chemicals identified as COPCs for each medium is provided in the following paragraphs. See Appendix G, Section 3.2.2 for a discussion of data evaluation procedures.

4.3.7.2.1 <u>Soils</u>

Several metals, acetone, di-n-butylphthalate, and methylene chloride were detected in one or more surface soil samples collected at SWMU 3. Barium, chromium, lead, and zinc, along with ethylbenzene, methylene chloride, and total xylenes were detected in one or more subsurface soil samples collected at SWMU 3. The occurrence and distribution of chemicals in surface and subsurface soils is presented in Tables 4-73 through 4-76. COPC selection results, summary statistics, and representative concentrations for chemicals detected in SWMU 3 environmental media are also presented on these tables. No chemicals detected in soils were selected as COPCs for SWMU 3. All inorganics were less than RBC screening values or at levels comparable to background and all organics were less than RBC screening values.

TABLE 4-71

PRELIMINARY RISK EVALUATION - CARCINOGENIC EFFECTS - SWMU 3
NAS KEY WEST

	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
Chemical*	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
INORGANICS											
Arsenic	0.68	10.25	ND	0.43	0.43	0.045	3.8	2E-06	2E-05	NA	2E-07
Beryllium	0.08	ND	ND	0.15	0.15	0.016	1.3	5E-07	NA	NA	6E-08
SEMIVOLATILE ORGANIC COMPOUNDS											
Bis(2-ethylhexyl)phthalate	ND	1,600	ND	46	46	4.8	410	NA	4E-08	NA	NA
VOLATILE ORGANIC COMPOUNDS											
Methylene chloride	27	48	1	85	85	4.1	760	3E-10	6E-10	2E-07	4E-11
Risk sums by medium								**3E-06**	**2E-05**	**2E-07**	**3E-07**
Risk sums by use scenario									**2E-05**		**3E-07**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCB concentrations are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
NA = Not applicable.

TABLE 4-72

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS - SWMU 3
NAS KEY WEST
PAGE 1 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
INORGANICS											
Aluminum	639	3,060	ND	78,000	78,000	37,000	1,000,000	8E-03	4E-02	NA	6E-04
Antimony	0.29	ND	11	31	31	15	820	9E-03	NA	7E-01	4E-04
Arsenic	0.68	10.25	ND	23	23	11	610	3E-02	5E-01	NA	1E-03
Barium	7	12.3	13	5,500	5,500	2,600	140,000	1E-03	2E-03	5E-03	5E-05
Beryllium	0.08	ND	ND	390	390	180	1,000	2E-04	NA	NA	8E-05
Cadmium	0.31	1.1	ND	39	39	18	1,000	8E-03	3E-02	NA	3E-04
Chromium VI	3.6	17.4	ND	390	390	180	10,000	9E-03	5E-02	NA	4E-04
Cobalt	0.17	0.58	ND	4,700	4,700	2,200	120,000	4E-05	1E-04	NA	1E-06
Copper	3.5	163	34	3,100	3,100	1,500	82,000	1E-03	5E-02	2E-02	4E-05
Cyanide	ND	14	62.7	1,600	1,600	730	41,000	NA	9E-03	9E-02	NA
Iron	330	3,500	67.6	23,000	23,000	11,000	610,000	1E-02	2E-01	6E-03	5E-04
Manganese	9	22.3	ND	390	390	180	10,000	2E-02	6E-02	NA	9E-04
Mercury	ND	0.14	ND	23	23	11	610	NA	6. -03	NA	NA
Nickel	1	2.9	2.2	1,600	1,600	730	41,000	6E-04	2E-03	3E-03	2E-05
Silver	ND	0.19	ND	390	390	180	10,000	NA	5E-04	NA	NA
Thallium	ND	ND	9	6.3	6.3	2.9	160	NA	NA	3E+00	NA
Tin	ND	18.5	126	47,000	47,000	22,000	1.00E+06	NA	4E-04	6E-03	NA
Vanadium	2	9.4	ND	550	550	260	14,000	4E-03	2E-02	NA	1E-04
Zinc	25.9	88.9	ND	23,000	23,000	11,000	610,000	1E-03	4E-03	NA	4E-05
SEMIVOLATILE ORGANIC COMPOUNDS											
Bis(2-ethylhexyl)phthalate	ND	1,600	ND	1,600	1,600	730	41,000	NA	1E-03	NA	NA
Di-n-butyl phthalate	110	ND	ND	7,800	7,800	3,700	200,000	1E-05	NA	NA	6E-07
Fluoranthene	ND	ND	0.24	3,100	3,100	1,500	82,000	NA	NA	2E-04	NA

TABLE 4-72

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS - SWMU 3
NAS KEY WEST
PAGE 2 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
Acetone	39	23	ND	7,800	7,800	3,700	200,000	5E-06	3E-06	NA	2E-07
Carbon disulfide	ND	34	ND	7,800	7,800	1,000	200,000	NA	4E-06	NA	NA
Cis-1,2-dichloroethene	ND	31	ND	780	780	61	20,000	NA	NA	NA	NA
Ethylbenzene	30	ND	ND	7,800	7,800	1,300	200,000	4E-06	NA	NA	2E-07
Methacrylonitrile	ND	2,700	ND	7.8	7.8	200	3.7	NA	NA	NA	NA
Methylene chloride	27	48	1	4,700	4,700	2,200	120,000	6E-06	1E-05	5E-04	2E-07
Xylenes (total)	37	ND	ND	160,000	160,000	12,000	1,000,000	2E-07	NA	NA	4E-08
Hazard sums by medium								**1E-01**	**1E+00**	**4.0E+00**	**4E-03**
Hazard sums by use scenario								**5E+00**			**4E-03**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCB concnetrations are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
NA = Not applicable.

TABLE 4-73

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE SOIL - SWMU 3 (µg/kg)
NAS KEY WEST

	Background			Site						
Chemical	Frequency of Detection	Range Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
SEMIVOLATILE ORGANIC COMPOUNDS										
Di-n-butyl phthalate	1/11	82	427	2/5	91-110	3,992	780,000	110	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	1/12	1	3.67	1/5	39	17	780,000	39	N	A
Methylene chloride	6/12	1.1-14	2.80	1/5	27	10	85,000	27	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max<2XBKGDAVE..

TABLE 4-74

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SURFACE SOIL - SWMU 3 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	11/11	120-4,250	2,130	4/4	213-639	363	7,800	639	N	A
Antimony	2/12	0.26-0.48	0.428	3/5	0.24-0.29	0.53	3.1	0.29	N	A
Arsenic	6/12	0.63-2.7	1.4	4/5	0.28-0.68	0.41	0.43	0.68	N	G
Barium	12/12	4.4-17.7	11	5/5	5.1-7.3	6.25	550	7.3	N	A
Beryllium	2/12	0.13-0.15	0.054	4/5	0.07-0.08	0.08	0.15	0.08	N	A
Cadmium	4/12	0.11-0.45	0.173	4/5	0.02-0.31	0.15	3.9	0.31	N	A
Calcium	11/11	265,000-449,000	362,000	4/4	371,500-379,000	374,875	–	378,845	N	D
Chromium	12/12	1.9-15.5	6.22	5/5	2-3	2.55	7,800	3	N	A
Cobalt	7/12	0.22-0.51	0.341	2/5	0.14-0.17	0.31	470	0.17	N	A
Copper	11/12	1.3-15.6	5.2	4/5	0.41-3.50	1.14	310	3.5	N	A
Iron	11/11	98.1-2,260	1,290	4/4	130-330	202.63	2,300	330	N	A
Lead	11/12	0.65-48.3	16.8	1/5	4.6	0.98	–	4.6	N	G
Magnesium	11/11	1,340-24,600	7,800	4/4	992-1,220	1,078	–	1,208	N	D
Manganese	11/11	2.6-33.7	19.4	4/4	2.2-8.6	4.69	39	8.6	N	A
Nickel	8/12	0.63-4.1	1.63	4/5	0.4-0.8	0.65	160	0.78	N	A
Potassium	11/11	48.6-944	356	4/4	37-87	61.39	–	87	N	D
Sodium	11/11	834-18,700	4,620	4/4	1,000-1,340	1,141	–	1,340	N	D
Vanadium	12/12	0.8-8.8	3.71	4/5	1.5-2	1.45	55	2	N	A
Zinc	12/12	0.63-89.1	19	5/5	0.75-6.6	2.99	2,300	6.6	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max<2XBKGDAVE.

TABLE 4-75

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs ORGANICS IN SUBSURFACE SOIL - SWMU 3 (µg/kg) NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
VOLATILE ORGANIC COMPOUNDS										
Ethylbenzene	1/12	0.31	1.65	1/1	30	30	20,000,000	30	N	A
Methylene chloride	6/12	0.11-14	2.80	1/1	21	21	760,000	21	N	A
Xylenes (total)	0/12	6	—	1/1	37	37	100,000,000	37	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-76

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SUBSURFACE SOIL - SWMU 3 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Barium	12/12	4.4-17.7	11	1/1	4	4	14,000	4	N	A
Chromium	12/12	1.9-15.5	6.22	1/1	3.6	3.60	100,000	3.60	N	A
Lead	11/12	0.65-48.3	16.8	1/1	6.8	6.80	--	6.80	N	G
Zinc	12/12	0.63-89.1	19	1/1	25.9	25.90	61,000	25.90	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

4.3.7.2.2 Sediment and Surface Water

Several metals, acetone, bis(2-ethylhexyl)phthalate, carbon disulfide, cis-1,2-DCE, methacrylonitrile, and methylene chloride were detected in one or more sediment samples collected at SWMU 3. Antimony, barium, copper, cyanide, lead, nickel and thallium along with fluoranthene were detected in surface water samples collected at SWMU 3. The occurrence and distribution of chemicals in sediment and surface water is presented in Tables 4-77 through 4-80. COPC selection results, summary statistics, and representative concentrations for chemicals detected in SWMU 3 environmental media are also presented on these tables. The following chemicals were selected as COPCs for SWMU 3 sediment and surface water:

SEDIMENT		**SURFACE WATER**	
Inorganics	Organics	Inorganics	Organics
Arsenic	None	Antimony	None
Iron		Lead*	
Lead*			

No qualitative toxicity values for lead (*) are available, therefore, lead will be evaluated qualitatively in the uncertainty section.

Arsenic was detected frequently (i.e., in greater than 50 percent of the samples analyzed) at concentrations in sediment that exceeded background and exceeded residential soil RBC screening criteria. Iron was detected in all five sediment samples slightly exceeding background and the residential soil RBC. Therefore, arsenic and iron were selected as COPCs. The iron concentration in sediment is similar to background concentrations. Uncertainty is associated with the selection of iron as a COPC, because it may represent background concentrations, which potentially overestimates the risk.

Antimony was detected in three out of eight samples in SWMU 3 surface water. The three detections of antimony in surface water ranged from 100 µg/L to 111 µg/L; greater than background concentrations and exceeding the residential tap water RBC of 1.5 µg/L. Antimony was selected as a COPC. The RBCs for tap water ingestion were used as a point of comparison because RBCs for typical surface water exposure (i.e., recreational exposures) are not currently published by EPA. It should be noted that surface water exposure (industrial/recreational) are generally less intensive than tap water exposure (i.e., exposures resulting from the typical domestic use of a water supply). Thus, the use of the tap water RBCs to select surface water COPCs is very conservative. None of the organics detected in the surface water samples were selected as COPCs.

TABLE 4-77

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SEDIMENT - SWMU 3 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	4/4	497-3,350	2,042	5/5	1,120-3,060	1,846	7,800	3,060	N	A
Arsenic	2/4	1.5-1.6	1.71	5/9	1.3-10.25	3.10	0.43	5.10	Y	C
Barium	5/5	5-15.2	9.88	9/9	5-12.3	8.26	550	10.37	N	A
Cadmium	2/5	0.12-0.9	0.42	5/9	0.41-1.1	0.87	3.9	1.10	N	A
Calcium	4/4	223,000-393,000	325,250	5/5	248,500-394,000	334,500	–	394,000	N	D
Chromium	5/5	2.1-11.7	6.94	9/9	5.2-17.4	9.26	7,800	12.57	N	A
Cobalt	2/5	0.12-0.56	0.88	1/9	0.58	2.06	470	0.58	N	A
Copper	5/5	0.76-34.6	9.01	9/9	8.1-163	42.09	310	128.67	N	A
Cyanide	0/5	Not detected	–	2/7	1.8-14	3.15	160,000	14	N	A
Iron	4/4	363-2,600	1,305	5/5	684-3,500	1,493	2,300	3,500	Y	C
Lead	4/5	5.5-56.5	24.65	9/9	9.1-136	50.53	–	136	Y	F
Magnesium	4/4	4,680-20,000	12,425	5/5	2,600-10,900	6,780	–	10,900	N	D
Manganese	4/4	14.9-38.5	21.95	5/5	9.8-22.3	15.81	39	22.30	N	A
Mercury	0/5	Not detected	–	2/9	0.05-0.14	0.08	2.3	0.13	N	A
Nickel	4/5	0.7-5.5	2.49	5/9	2.2-2.9	3.26	160	2.90	N	A
Potassium	4/4	517-4,180	1,469	5/5	126-1,700	893.20	–	1,700	N	D
Silver	0/5	Not detected	–	1/9	0.19	0.61	39	0.19	N	A
Sodium	4/4	5,500-86,900	28,788	5/5	2,620-21,700	11,060	–	21,700	N	D
Tin	1/2	0.99-0.99	2.85	1/4	18.5	10.00	4,700	18.50	N	A
Vanadium	5/5	2.8-8.9	4.84	6/9	2.9-9.4	4.39	55	8.16	N	A
Zinc	5/5	3.5-58.2	30.40	9/9	28.2-88.9	51.55	2,300	74.03	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-78

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SEDIMENT - SWMU 3 (µg/kg)
NAS KEY WEST

	Background			Site						
Chemical	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average	Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	1/5	4,500-4,500	229.9	2/3	1,400-1,600	1,917	46,000	1,600	N	A
VIOLATILE ORGANIC COMPOUNDS										
Acetone	3/5	4-120	34.3	2/3	11-23	21.67	780,000	23	N	A
Carbon disulfide	0/5	Not detected	—	1/3	34	17	780,000	34	N	A
Cis-1,2-dichloroethene	0/2	Not detected	—	2/5	19-31	13.91	78,000	31	N	A
Methacrylonitrile	0/5	Not detected	—	1/3	2,700	911	7,800	2,700	N	A
Methylene chloride	2/5	5-20	7.6	3/5	36-48	36.60	85,000	48	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.

TABLE 4-79

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SURFACE WATER - SWMU 3 (µg/L)
NAS KEY WEST

Chemical	Background			Site			Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Antimony	2/5	3.5-7.3	2.9	3/8	100-111	39.70	1.5	111	Y	C
Barium	6/6	5.8-16.3	9.05	8/8	6.70-13	8.36	260	9.8	N	A
Calcium	5/5	105,000-326,000	200,000	5/5	142,000-156,500	150,300	–	155,739	N	D
Copper	1/7	2	2.05	3/8	1.3-34.4	9.08	150	34.4	N	A
Cyanide	0/5	Not detected	–	2/6	36.80-62.70	25.37	73	62.7	N	A
Iron	2/5	61.6-170	47.22	1/5	67.6	21.91	1,100	67.6	N	A
Lead	0/6	Not detected	–	2/8	4.3-4-14	3.15	–	11.5	Y	F
Magnesium	5/5	193,000-1,360,000	683,600	5/5	303,000-354,000	321,000	–	341,289	N	D
Nickel	0/7	Not detected	–	2/8	1.6-2.2	4.47	73	2.2	N	A
Potassium	5/5	70,600-418,000	227,000	5/5	103,000-119,000	109,500	–	115,470	N	D
Sodium	5/5	1,720,000-11,800,000	5,980,000	5/5	2,690,000-3,270,000	2,851,000	–	3,088,167	N	D
Thallium	2/7	7.4-12	4.88	6/8	3.3-8.5	4.84	0.29	8.1	N	A
Tin	0/4	Not detected	–	1/3	126	52	2,200	126	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-80

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE WATER - SWMU 3 (µg/L)
NAS KEY WEST

Chemical	Background Frequency of Detection	Background Range of Positive Detection	Site Frequency of Detection	Site Range of Positive Detection	Site Average	Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
SEMIVOLATILE ORGANIC COMPOUNDS									
Fluoranthene	0/7	Not detected	1/3	0.24	1.76	150	0.24	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

** A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

Methods for selection of COPCs and development of representative concentrations, and other data evaluation procedures are presented in Section 3.2.2 of Appendix G.

4.3.7.3 Toxicity Assessment

The toxicological profiles for selected COPCs at SWMU 3 are shown in Appendix A. All relevant quantitative and qualitative toxicity assessment information and methods were presented in Section 3.2.3 of Appendix G.

4.3.7.4 Exposure Assessment

The COPCs selected for each environmental media sampled at SWMU 3 are presented in Section 4.3.7.2. The potential receptors identified in Appendix G, Section 3.2.4.2, applicable to media sampled at SWMU 3 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. However, only the current adolescent and adult trespassers and future child and adult residents (discussed in Appendix G, Section 3.2.4) were evaluated quantitatively, because COPCs were selected for sediment and surface water only. All exposure parameters, exposure routes, and other relevant exposure assessment information was presented in Section 3.2.4 of Appendix G. Example calculations from estimated intakes are also presented in Appendix A.

4.3.7.5 Risk Characterization

This section presents the results of the quantitative risk assessment. Table 4-81 presents the estimated cumulative carcinogenic and noncarcinogenic risks for hypothetical future residents, trespasser adults and children, maintenance workers, and occupational workers at SWMU 3. The total risk for each exposure route and the cumulative risk across all exposure pathways are provided. The risks associated with a particular COPC are provided in the risk assessment spreadsheets in Appendix A. This section discusses the human health risk assessment in three parts:

- Carcinogenic Risks
- Noncarcinogenic Risks
- The results of the evaluation of lead in surface soils using the IEUBK Model

Additionally, a comparison of groundwater results to screening criteria and a special note concerning fish are presented in this section.

TABLE 4-81

CUMULATIVE RISKS
SWMU 3*
NAS KEY WEST

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
SURFACE SOIL						
Incidental ingestion	**	**	**	**	NA	**
Dermal contact	**	**	**	**	NA	**
Inhalation of fugitive dust	**	**	**	**	NA	**
Subtotal of Media	**	**	**	**	NA	**
SUBSURFACE SOIL						
Incidental ingestion	NA	NA	NA	NA	**	NA
Dermal contact	NA	NA	NA	NA	**	NA
Inhalation of fugitive dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
SEDIMENT						
Incidental ingestion	3E-06	4E-07	4E-07	NA	NA	NA
Dermal contact	1E-05	3E-06	2E-06	NA	NA	NA
Subtotal of Media	1E-05	3E-06	2E-06	NA	NA	NA
SURFACE WATER						
Incidental ingestion	**	**	**	NA	NA	NA
Dermal contact	**	**	**	NA	NA	NA
Subtotal of Media	**	**	**	NA	NA	NA
TOTAL	1E-05	3E-06	2E-06	**	**	**
HAZARD INDEX						
SURFACE SOIL						
Incidental ingestion	**	**	**	**	NA	**
Dermal contact	**	**	**	**	NA	**
Inhalation of fugitive dust	**	**	**	**	NA	**
Subtotal of Media	**	**	**	**	NA	**
SUBSURFACE SOIL						
Incidental ingestion	NA	NA	NA	NA	**	NA
Dermal contact	NA	NA	NA	NA	**	NA
Inhalation of fugitive dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
SEDIMENT						
Incidental ingestion	1E-01	5E-03	9E-03	NA	NA	NA
Dermal contact	1E-01	3E-02	4E-02	NA	NA	NA
Subtotal of Media	2E-01	4E-02	5E-02	NA	NA	NA

TABLE 4-81

CUMULATIVE RISKS
SWMU 3*
NAS KEY WEST
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX (cont.)						
SURFACE WATER						
Incidental ingestion	7E-01	6E-02	1E-01	NA	NA	NA
Dermal contact	3E-01	3E-02	4E-02	NA	NA	NA
Subtotal of Media	1E+00	9E-02	1E-01	NA	NA	NA
TOTAL	**1E+00**	**1E-01**	**2E-01**	**	**	**

* = Chemical-specific risks are presented in Appendix A.
** = Either no COPCs were selected or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not applicable, pathway is not applicable for the respective media.

4.3.7.5.1 Carcinogenic Risks

The estimated carcinogenic risk for future residents (1E-05), adult trespassers (3E-06) and adolescent trespassers (2E-06) is within EPA's "target risk range" of 1E-04 to 1E-06. Dermal contact with sediment for the future resident, adult trespasser, and adolescent trespasser have incremental cancer risks of 1E-05, 3E-06, and 2E-06. This exposure route contributes the most to the cumulative carcinogenic risk for these potential receptors. The dermal contact with COPC route is associated with high uncertainty based on the $ABSEFF_{oral}$ presented in Appendix G, Section 3.2.3.4. The principal COPC contributing to these cancer risks was arsenic in sediment. The estimated carcinogenic risks for the maintenance worker, excavation worker, and occupational worker were not estimated because no COPCs were selected in soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.3.7.5.2 Noncarcinogenic Risks

The cumulative HI for the hypothetical future resident slightly exceeds 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. The principal COPCs contributing to the noncarcinogenic risk are antimony in surface water (HQ = 1.0) and arsenic in sediment (HQ = 0.2). The target organs for antimony (heart) and arsenic (skin) are different. Therefore, no HI based on the same target organ would exceed 1.0 for the surface soil ingestion exposure route. The cumulative HIs for adolescent trespassers and adult trespassers at SWMU 3 are less than 1.0. The estimated noncarcinogenic risks for the maintenance worker, excavation worker, and occupational worker were not estimated because no COPCs were selected in soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.3.7.5.3 IEUBK Lead Results

Lead was not selected as COPC in SWMU 3 surface soils and is therefore not evaluated using the IEUBK Lead Model.

4.3.7.5.4 Groundwater and the Quantitative Risk Assessment

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, nonpotable, by FDEP. As discussed in Section 3 and in Appendix G, Section 3.2.2.2, groundwater obtained from the surficial aquifer at Key West has a high salinity, and the public water supply obtained from the mainland is officially designated as the only potable source. No freshwater public or registered domestic wells exist, although domestic wells are reportedly used for purposes such as flushing water.

Although treatment could possibly be used to improve water quality, the local water authority regulates all potable supplies in the Keys.

A preliminary comparison of unfiltered groundwater concentrations at SWMU 3 versus tap water RBCs (EPA, 1995b) and MCLs (EPA, 1995c) is presented in Tables 4-82 and 4-83 for inorganics and organics, respectively. The results of this preliminary comparison for SWMU 3 are:

- The maximum values of antimony, gamma-BHC, heptachlor, and benzene exceeded both MCLs and RBC screening criteria. Antimony was detected in seven out of eight samples, and exceeded both the MCL and the tap water RBC in all samples in which it was detected. Gamma-BHC was detected in only one out of seven samples, but exceeded both the MCL and the tap water RBC in that sample. Heptachlor was detected in one out of eight samples at levels above the MCL and above the tap water RBC. Benzene was detected in 2 out of 18 samples at levels above the MCL and above the tap water RBC. One sample was slightly lower than the MCL value, yet still exceeded the tap water RBC.

- The maximum values of aldrin, alpha-BHC, beta-BHC, 1,1-dichloroethene, methylene chloride, vinyl chloride, and arsenic exceeded only their maximum RBC values. Aldrin, alpha-BHC, beta-BHC, and gamma-BHC were all detected in one out of eight samples at a level above their respective RBCs. All of their levels were slightly above the maximum RBC values. 1,1-dichloroethene was detected in only 1 out of 18 samples, but at a level that is over 300-fold the value of its tap water RBC value. Methylene chloride was detected in 6 out of 18 samples. The maximum range of the samples was only slightly above the RBC value. Vinyl chloride was detected in 7 out of 17 samples at levels far exceeding the tap water RBC value. Antimony and arsenic were detected in seven and eight out of nine samples, respectively. Both were at levels that were at very high magnitudes exceeding their respective RBCs.

4.3.7.5.5 Fish and the Quantitative Risk Assessment

Fish and shellfish at SWMU 3 were not considered a human health concern because intensive fish collection activities showed that the contaminants detected in SWMU 3 fish were generally present in concentration similar to those from background fish sampling locations. In addition, the active airfield prohibits site access with locked gates or airport security monitoring. A more complete discussion of this subject is presented in Section 3.2.2.3 of Appendix G.

TABLE 4-82

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs INORGANICS IN GROUNDWATER - SWMU 3 (µg/L) NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	0/3	Not detected	–	4/4	67.10-12,300	6,614	NL	NA	37,000	N
Antimony	0/5	Not detected	–	7/9	71.90-161	98.16	6	Y	15	Y
Arsenic	3/6	4.1-11.9	4.33	8/9	4.20-39.30	19.08	50	N	0.045	Y
Barium	6/6	6.6-19.45	13.9	9/10	10.40-226	44.09	2,000	N	2,600	N
Calcium	3/3	114,250-243,500	181,000	4/4	229,000-12,700,000	7,012,250	NL	NA	NL	NA
Chromium	2/6	0.71-13	4.09	8/12	10.10-73.50	20.47	100	N	180	N
Copper	0/6	Not detected	–	5/11	10.40-91.90	19.67	1,300	N	1,500	N
Iron	2/3	76.2-97.4	62.6	4/4	1,230-4,940	2,718	NL	NA	11,000	N
Magnesium	3/3	123,750-820,250	433,000	4/4	152,000-1,180,000	707,750	NL	NA	NL	NA
Manganese	2/3	3.9-10.3	4.87	2/3	42.40-62.20	35.20	NL	NA	180	N
Mercury	1/6	0.13	0.08	3/11	0.23-0.39	0.15	2	N	11	N
Potassium	3/3	38,850-181,750	119,000	4/4	70,900-343,000	216,475	NL	NA	NL	NA
Silver	0/6	Not detected	–	1/9	22.60	4.73	NL	NA	180	N
Sodium	3/3	982,250-6,615,000	3,670,000	4/4	1,330,000-9,340,000	5,787,500	NL	NA	NL	NA
Sulfide	3/3	10,000-52,000	28,000	3/3	2,000-54,000	23,667	NL	NA	NL	NA
Tin	0/3	Not detected	–	1/8	73.6	21.7	NL	NA	22,000	N
Vanadium	0/6	Not detected	–	2/10	14.80-58.1	11.29	NL	NA	260	N
Zinc	3/6	3.425-15.3	4.94	7/10	5.9-45.5	15.05	NL	NA	11,000	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum Contaminant Level (EPA, 1995c).
**RBC = Risk-Based Concentration (EPA, 1995b).

TABLE 4-83

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs ORGANICS IN GROUNDWATER - SWMU 3 (µg/L) NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
Aldrin	0/6	Not detected	–	1/8	0.11	0.08	NL	NA	0.004	Y
Alpha-BHC	0/6	Not detected	–	1/8	0.35	0.11	NL	NA	0.011	Y
Beta-BHC	0/6	Not detected	–	1/8	1	0.19	NL	NA	0.37	Y
Delta-BHC	0/6	Not detected	–	1/8	0.3	0.10	NL	NA	NL	NA
Gamma-BHC	0/6	Not detected	–	1/8	0.75	0.16	0.2	Y	0.052	Y
Heptachlor	0/6	Not detected	–	1/8	0.42	0.12	0.4	Y	0.0023	Y
SEMIVOLATILE ORGANIC COMPOUNDS										
1-methylnaphthalene	0/0	Not sampled	–	1/1	33	33.00	NL	NA	NL	NA
2,4-dimethylphenol	0/4	Not detected	–	1/9	43	11.44	NL	NA	740	N
2-methylnaphthalene	0/4	Not detected	–	4/9	10-67	14.44	NL	NA	1,500	N
Naphthalene	1/4	2	4.09	6/14	4.5-114	18.33	NL	NA	1,500	N
VOLATILE ORGANIC COMPOUNDS										
1,1-dichloroethane	0/3	Not detected	–	2/18	2-19	2.76	NL	NA	810	N
1,1-dichloroethene	0/3	Not detected	–	1/18	3.1	2.08	7	N	0.044	Y
4-methyl-2-pentanone	0/3	Not detected	–	1/12	3	5.88	NL	NA	NL	NA
Acetone	1/3	5	5	5/12	3-46	9.42	NL	NA	3,700	N
Benzene	0/3	Not detected	–	2/18	4-11	2.61	5	Y	0.36	Y
Bromomethane	0/3	Not detected	–	1/18	3	3.03	NL	NA	8.7	N
Carbon disulfide	0/3	Not detected	–	7/12	2-12	5.50	NL	NA	1,000	N
Chloroethane	0/3	Not detected	–	1/18	1	3.25	NL	NA	8,800	N
Cis-1,2-dichloroethene	0/3	Not detected	–	2/7	3-3.7	1.60	70	N	61	N
Ethylbenzene	0/3	Not detected	–	4/18	5-15	3.39	700	N	1,300	N
Iodomethane	0/3	Not detected	–	1/8	6	5.75	NL	NA	NL	NA
Methylene chloride	2/3	1	1.5	6/18	2-5	5.19	5	N	4.1	Y
Toluene	0/3	Not detected	–	2/18	1-2	1.94	1,000	N	750	N
Trans-1,2-dichloroethene	0/2	Not detected	–	1/14	6	2.14	100	N	120	N
Vinyl acetate	0/3	Not detected	–	1/12	3	5.88	NL	NA	37,000	N
Vinyl chloride	0/3	Not detected	–	2/18	7.1-17	4.01	1,000	N	0.019	Y
Xylenes (total)	0/3	Not detected	–	7/17	1-17	3.46	10,000	N	12,000	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum Contaminant Level (EPA, 1995c).
**RBC = Risk-Based Concentration (EPA, 1995b).

4.3.7.6 Uncertainties for SWMU 3

Beyond the uncertainties associated with the HHRA process discussed in Appendix G, the following uncertainties should be considered in any evaluation of SWMU 3 risk assessment results:

- The uncertainty associated with the dermal exposure is high because of the derivation of the dermal reference dose (See Appendix G, Section 3.2.3.4). Dermal exposure is a primary contributor to the cumulative cancer risk (via sediment) for the hypothetical future residential receptor. The uncertainty associated with the dermal exposure route may overestimate the risk at SWMU 3.

- Iron was selected as a COPC in sediment, but it was detected at levels in SWMU 3 that slightly exceed background levels. The inclusion of iron as a site-related sediment COPC could overestimate the quantitative risk at SWMU 3 for the hypothetical future residential receptor. Additionally there is high uncertainty associated with the oral RfD for iron.

- Use of residential RBCs (sediment) and tap water RBCs (surface water) probably influences the selection of COPCs at the site by potential designated chemicals as COPCs that do not contribute significantly to the quantitative risk at SWMU 3 (i.e., iron and arsenic in sediment). This bias is based on the fact that sediment exposure is generally well below intakes a receptor would be exposed to under a true residential soil exposure pathway.

- Lead was determined to be a COPC in sediment and surface water at SWMU 3. Lead exposure to sediment and surface water is not estimated under the IEUBK Lead Model for the baseline HHRA at SWMU 3. This probably underestimates the risks to potential receptors exposed to lead in sediment and surface water, especially residential children.

4.3.7.7 Chemicals of Concern and Remedial Goal Options

At SWMU 3, no COCs were selected for RGO analysis because in no instance did any receptor scenario have a total risk (combined across pathways) exceeding a level of concern (1E-04 cancer risk or HI of 1.0). Section 3.2.7 of Appendix G further describes the ARARs, TBCs, and risk-based criteria used in selecting COCs (RCRA Corrective Action Levels, FDEP SCGs, and AWQC).

4.3.7.8 Conclusions

The primary objectives of investigation at SWMU 3 were to identify existing nature and extent of contamination (after a previous interim remedial action at the SWMU) in the on-site media to provide a baseline HHRA of COPCs identified in those media, and to perform an ecological risk assessment.

Noncarcinogenic and carcinogenic human health risks were estimated for potential current (trespasser) and hypothetical future (residents) receptors.

COPCs in SWMU 3 media were not present at sufficient concentrations to cause adverse noncarcinogenic health effects to any current receptors. The cumulative HI for the hypothetical future resident slightly exceeds the benchmark level below which adverse noncarcinogenic health effects are not anticipated. The cancer risks estimated for any current or future potential receptors were below or within the 1E-04 to 1E-06 target risk range, often used by EPA in setting standards and criteria and in evaluating the need for environmental remediation.

The future land uses planned for this site (i.e., military base with restricted access or zoned future limited access because of existing conditions, e.g., areas near the active airstrip) do not include residential land use for the foreseeable future.

The results of the baseline HHRA for all media evaluated at SWMU 3 support a decision for no further action.

4.3.8 <u>Ecological Risk Assessment</u>

This section presents the results of the ecological risk assessment (ERA) performed at SWMU 3 through a discussion of the problem formulation, effects characterization, exposure assessment, and risk characterization.

4.3.8.1 Problem Formulation

This section presents the ecological problem formulation through a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of ECPCs, assessment and measurement endpoints, and the conceptual site model.

4.3.8.1.1 Habitat Types and Ecological Receptors

Section 4.3.1 (see Figure 4-34) describes the physical setting at SWMU 3. Most of SWMU 3 is paved or covered with gravel, which precludes the existence of significant terrestrial habitat. The shallow lagoon provides habitat for a variety of small schooling fish species (e.g., sheepshead minnow, sailfin molly, and mosquitofish) that are able to tolerate extreme fluctuations in water temperature, salinity, and dissolved oxygen concentrations. Larger predatory fish such as tarpon, ladyfish, and snapper appear to be absent based on 1996 fish sampling. Wading birds, such as great blue herons and tricolored herons, were observed foraging in the lagoon during sampling activities. Fish were collected for tissue analysis for this assessment from the portion of the lagoon nearest to SWMU 3. A small ponded area approximately 500 feet northeast of SWMU 3 is also lined with mangroves. However, the pond area does not appear to be hydrologically connected with the lagoon.

4.3.8.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

The major contaminant sources at SWMU 3 are the former burn pits. The potential contaminant release pathways at the site include combustion, volatilization, wind erosion, overland runoff, and infiltration of contaminants. Constituents in the site soil can volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust can also be generated during ground-disturbing activities, such as construction or excavation. These contaminants are dispersed in the surrounding environment and transported to downwind locations where they can repartition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition. However, the burn pit areas are relatively small, precluding extensive fugitive dust or gaseous emissions.

Precipitation runoff can carry constituents to nearby surface waters, sediments, and surface soils, but primarily to surface water and sediments in the lagoon. Infiltrating precipitation can cause the contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in soil are likely to migrate at a slower rate. On infiltrating the soil column and reaching the water table, a contaminant can be carried with the flow of groundwater to downgradient locations. Groundwater at the site is shallow and probably is hydrologically connected to surface water in the lagoon; contaminants can be deposited in sediment or they can accumulate in the tissues of aquatic organisms.

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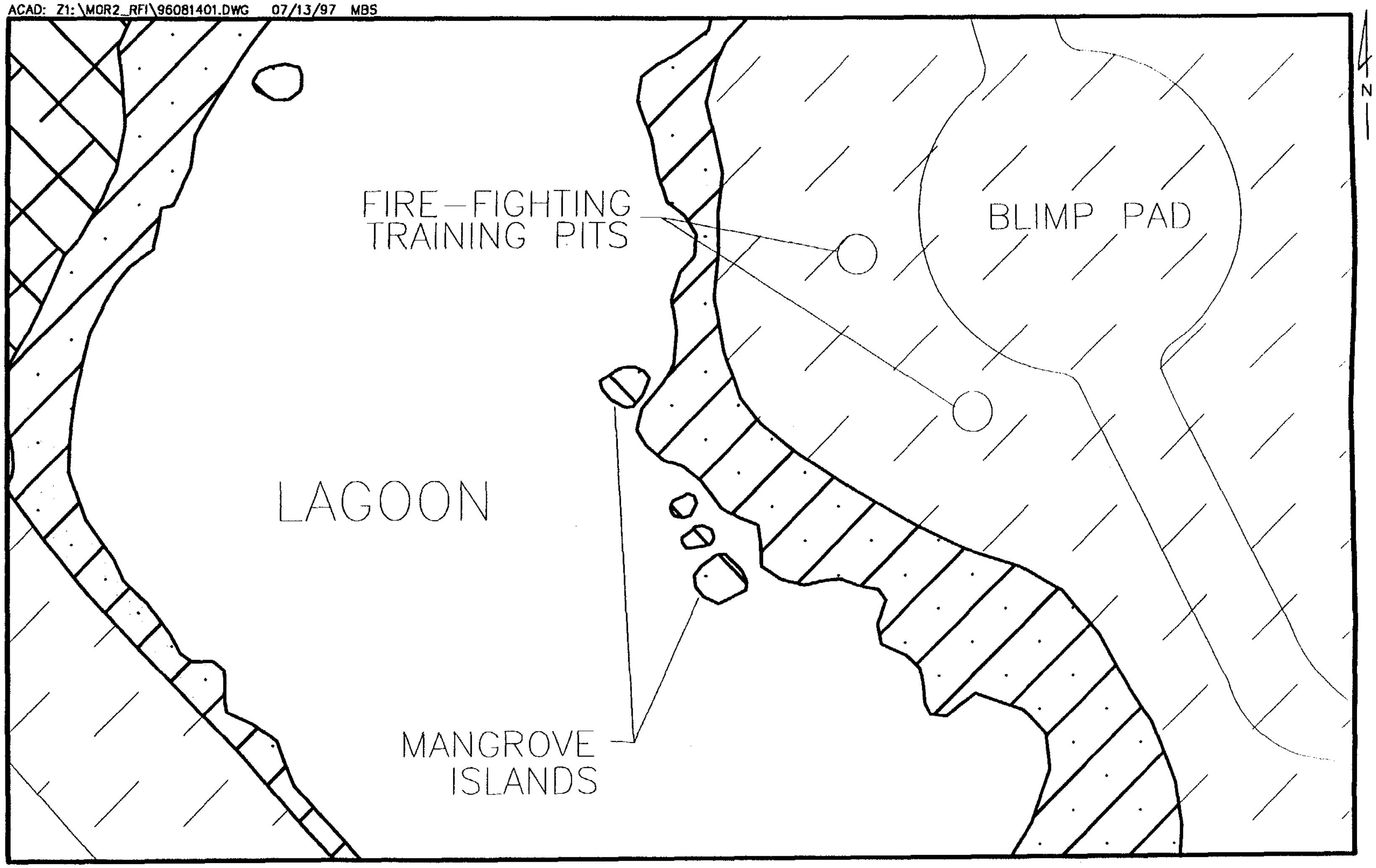


Brown & Root Environmental

0 200 400

SCALE IN FEET

LEGEND

- UPLAND/FILLED (MOWED OR EXOTICS)
- POND/ NATURAL
- MIXED MANGROVE
- UPLAND/NATURAL ELEVEATION (MOWED)
- CATTAIL/SPIKERUSH (NONTIDAL)

FIGURE 4-34. HABITATS AT SWMU 3 FIRE-FIGHTING TRAINING AREA

NAS KEY WEST | KEY WEST, FLORIDA

DRAWN BY: MBS	SCALE: –	DATE: 08/08/96	REV: 0
CHECKED BY: MLW	CONTRACT NO.: –	FILE NAME: KEY WEST/T1/96081401.DWG	

4.3.8.1.3 Exposure Routes

Terrestrial receptors at SWMU 3 can be exposed to soil contaminants through the incidental ingestion of soil and ingestion of contaminated food items. Animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants via direct aerial deposition and root translocation. Terrestrial receptors can come into contact with contaminants in surface water by drinking that water, although this exposure route represents a negligible portion of total exposure for most receptors because the water has a high salt content. However, terrestrial habitat is limited and of marginal quality due to the paved and graveled nature of the site. Terrestrial receptor use of the area is minimal, and scattered patches of weeds are the only vegetation present with the exception of a narrow fringe of mangroves along the edge of the lagoon. Therefore, terrestrial exposure routes at this site are present only to a minimal extent and represent a negligible portion of total exposure.

Volatile constituents are present in some site soils, soil-bound contaminant resuspension can occur, and combustion can release contaminants into the air at SWMU 3. However, inhalation does not represent a significant exposure pathway because air contaminant concentrations are assumed to be quite low, even for burrowing wildlife. In addition, the inhalation pathway is generally insignificant for ecological receptors, and inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Aquatic and terrestrial organisms inhabiting the lagoon near SWMU 3 may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semiaquatic organisms can be exposed to constituents in contaminated groundwater that flows into surface water.

4.3.8.1.4 Selection of Ecological Contaminants of Potential Concern

ECPCs were all contaminants detected during current and previous sampling of surface water, groundwater, sediment, and surface soil at SWMU 3. However, calcium, iron, magnesium, potassium, sodium, and sulfate were excluded as ECPCs in all media because they are essential nutrients that are toxic only in extremely high concentrations. In addition, inorganic contaminants whose maximum detected concentration was less than two times the average background concentration were excluded as ECPCs. This comparison to background is recommended by EPA (1996) since concentrations of inorganics can be naturally elevated and not due to base-related contaminant releases.

4.3.8.1.5 Assessment and Measurement Endpoints

A detailed description of assessment and measurement endpoints for this ERA is presented in Section 3.3.1.1.6 of Appendix G.

4.3.8.1.6 Conceptual Site Model

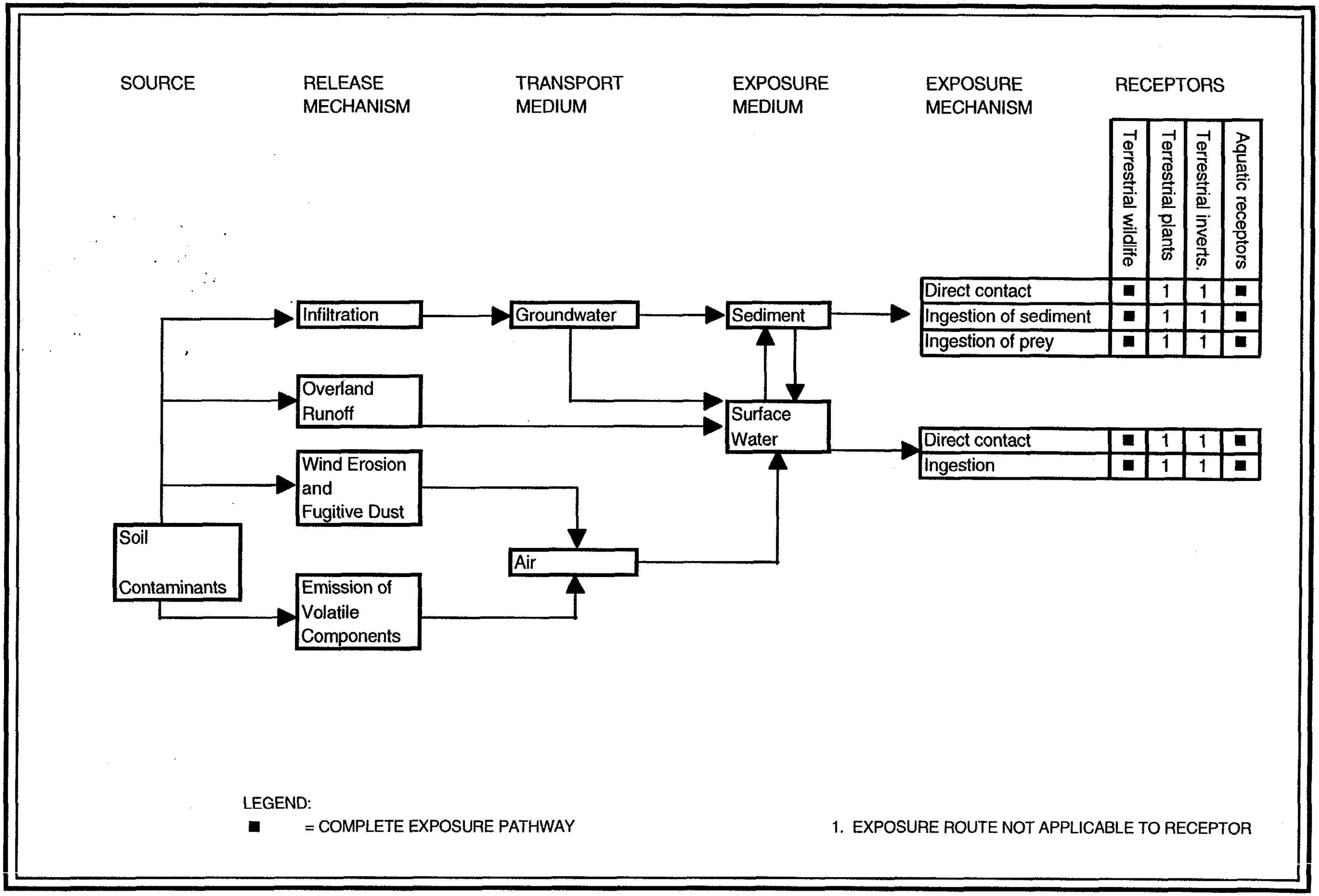
The conceptual model is designed to identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the Supplemental RFI/RI sites were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Figure 4-35 shows the conceptual model for SWMU 3.

4.3.8.2 Ecological Effects Characterization

Ecologically based benchmarks, which are concentrations of contaminants in various media protective of ecological receptors, were selected to screen exposure point concentrations of ECPCs in surface water, ground water, sediment, and soil to determine if they qualify as ECCs at SWMU 3. Surface-water, ground water, and sediment benchmarks used in this ERA are presented in Appendix G. Although exposure to contaminated surface soil is expected to be minimal, surface soil benchmarks were conservatively utilized for SWMU 3 and are presented in Appendix G. A discussion of benchmark selection is provided in Section 3.3.1.2 of Appendix G.

Toxicity tests were performed using surface water and sediment collected from the edge of the lagoon at SWMU 3. Surface water was evaluated using the silverside minnow, and sediment was evaluated using the amphipod *Hyallela azteca*. Results of the toxicity tests were compared to results in concurrently tested laboratory control samples.

Fish were collected from the edge of the lagoon immediately west of the site and analyzed for volatile organic compounds, semivolatile compounds, pesticides, PCBs, and metals. Concentrations of contaminants detected in the fish were compared to concentrations in fish collected at background sites (Table 4-84) and to benchmark concentrations considered to be protective of piscivorous receptors (Table 4-25).



7046-25\PC\mod-0\F4-35cs3.ppt

Figure 4-35. Conceptual Site Model - SWMU 3, NAS Key West, Boca Chica Key, Florida

TABLE 4-84

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 3 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 1 OF 2

Chemical	SWMU 3			Background			
	Frequency of Detection	Range of Detected Values	Average(1)	Frequency of Detection	Range of Detected Values	Average(1)	Average of all Background Values for All Species(1)
INORGANICS							
ARSENIC							1.64
Sailfin molly	4/16	0.27 - 4.3	0.8	2/12	0.89 - 1.10	0.25	
American eel	1/1	2.7	2.7	NC			
BARIUM							1.01
Sailfin molly	14/16	1.5 - 3.6	2.19	12/12	1.90 - 3.90	2.88	
Killifish	1/3	0.59	0.52	0/12			
Sheepshead minnow	3/3	2.6 - 4.7	3.47	6/6	0.91 - 2.00	1.17	
COPPER							3.13
Sailfin molly	16/16	1.7 - 10	6.0	12/12	1.40 - 10.20	4.16	
Killifish	3/3	1.1 - 2.2	1.6	12/12	0.95 - 22.80	4.41	
Sheepshead minnow	3/3	13.5 - 51.6	27.4	6/6	2.80 - 10.30	5.43	
LEAD							1.18
Sailfin molly	15/16	0.15 - 0.78	0.36	9/12	0.14 - 5.30	0.60	
Sheepshead minnow	3/3	0.81 - 1.5	1.17	6/6	0.33 - 11.90	7.97	
MERCURY							0.03
American eel	1/1	0.05	0.05	NC			
SELENIUM							0.35
Sailfin molly	10/16	0.27 - 1.0	0.37	11/12	0.24 - 0.42	0.32	
Sheepshead minnow	2/3	0.27 - 0.32	0.28	6/6	0.40 - 0.61	0.46	
American eel	1/1	0.25	0.25	NC			
SILVER							ND
Sailfin molly	2/16	4 - 4.6	1.0	0/12			
Sheepshead minnow	1/3	0.55	0.52	0/6			
ZINC							32.4
Sailfin molly	16/16	19.1 - 535	88.74	12/12	13.60 - 45.40	31.06	
Killifish	3/3	37.4 - 53.1	47.2	12/12	23.40 - 60.70	31.85	
Sheepshead minnow	3/3	37.7 - 48.9	42.1	6/6	23.30 - 45.50	37.02	
American eel	1/1	5.6	5.6	NC			
PESTICIDES/PCBs							
4,4'-DDE							44.3
Sailfin molly	16/16	9.8 - 21.3	17.53	12/12	10.3 - 68.3	25.3	
Killifish	3/3	17.7 - 25.1	20.23	12/12	27.6 - 106	68.8	
Sheepshead minnow	3/3	8 - 11.3	10.2	6/6	21.2 - 34.1	26.0	
American eel	1/1	20.5	20.5	NC			

TABLE 4-84

SUMMARY STATISTICS FOR ALL ANALYTES DETECTED IN FISH COLLECTED AT SWMU 3 DURING JANUARY 1996, COMPARED TO VALUES IN FISH COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITES NAS KEY WEST PAGE 2 OF 2

	SWMU 3			Background			
Chemical	Frequency of Detection	Range of Detected Values	Average(1)	Frequency of Detection	Range of Detected Values	Average(1)	Average of all Background Values for All Species(1)
PESTICIDES/PCBs (cont.)							
AROCLOR-1260							49.3
Sailfin molly	16/16	60 - 357	203.25	8/12	29.0 - 60.0	33.3	
Killifish	3/3	36 - 113	74.7	6/12	39.0 - 165	51.2	
Sheepshead minnow	2/3	39 - 78	45.7	2/6	27.0 - 55.0	20.5	
American eel	1/1	81	81	NC			

1 One half the detection limit used for all non-detected values.
NC = Species not collected from background sites during January 1996 sampling.
ND = Not detected in any background sample.

NOTE: Samples consisted of sailfin molly (Poecilia latipinna), marsh killifish (Fundulus confluentus), sheepshead minnow (Cyprinodon variegatus) and American eel (Anguilla rostrata). All samples were analyzed for volatiles, semi-volatiles, metals, pesticides, and PCBs. Values for metals are mg/kg (ppm); values for pesticides and PCBs are μg/kg (ppb).

4.3.8.3 Exposure Assessment

This section presents the ecological exposure assessment for SWMU 3 through a discussion of exposure point contaminant concentrations and ecological dose calculations.

4.3.8.3.1 Exposure Point Contaminant Concentrations

Data used to obtain contaminant concentrations in environmental media at SWMU 3 were those generated from previous sampling activities. Maximum contaminant concentrations were used as representative concentrations in screening assessments of groundwater, surface water, sediment, and soil. Background values were obtained from several locations at NAS Key West. Background sampling is described in detail in Appendix J.

An ecological screening assessment was conducted at SWMU 3 as part of RFI/RI Phase I activities at NAS Key West (IT Corporation, 1994). For that screening-level assessment, the maximum contaminant concentrations detected in surface-water, groundwater, sediment, and surface soil samples taken as part of Phase I field activities were compared to selected background values and benchmark values. Contaminants were eliminated as potential COCs if they failed to meet several criteria, including a maximum concentration less than a conservative benchmark, low mobility or bioaccumulation potential, and detection in less than 5 percent of samples. Also, maximum contaminant concentrations in selected media were multiplied by BCFs to obtain predicted contaminant concentrations in prey. Contaminant concentrations in prey were compared to reference toxicity values from the literature for selected receptor species. The results of the preliminary ecological risk assessment for SWMU 3 are presented in Section 4.3.8.4.1.

4.3.8.3.2 Dose Calculations

Because exposure to surface soil and related contaminants is expected to be minimal at SWMU 3, dose calculations and food-chain modeling based on soil contaminant concentrations were not performed at the site.

4.3.8.4 Risk Characterization

This section presents the results and a discussion of the ecological risks at SWMU 3.

4.3.8.4.1 Results

The results of the ecological risk characterization at SWMU 3 are presented in this section with a discussion of the results from the Phase I and Phase II ecological screening assessments, toxicity assessment, and tissue analyses.

4.3.8.4.1.1 Phase I Ecological Screening Assessment

The Phase I ecological screening assessment (IT Corporation, 1994) identified antimony, chromium, vanadium, several PAHs, and several organics as COCs in groundwater. In surface water, barium, lead, ethylbenzene, and kepone were identified as COCs. For sediments, barium, lead, tin, and methyacrylonitrile were COCs, and in soils, several metals and PAHs were identified as COCs. The Phase I study indicated that the greatest potential risk to aquatic organisms at SWMU 3 is from direct contact with metals via surface water and sediment. Groundwater-related potential risks appeared to be minimal. Organics and PCBs appeared to pose minimal risk in surface water, though kepone slightly exceeded a toxicity reference value for sediment. Moderate potential risks also appeared to exist to piscivores from ingestion of several different contaminants in prey, including some metals, PAHs, and organochlorine pesticides.

4.3.8.4.1.2 Phase II Ecological Screening Assessment

In the current Phase II ecological screening assessment, the following chemicals were detected in groundwater at concentrations that exceeded surface water benchmarks and were retained as ECCs: aluminum, barium, chromium, copper, mercury, silver, vanadium, xylene, 2,4-dimethylphenol, and naphthalene (Table 4-85). Tin and several organics were retained as ECCs because no suitable benchmarks were available. In site surface water, copper, cyanide, lead, and tin exceeded benchmarks and were retained as ECCs (Table 4-86). In site sediments, the following chemicals exceeded benchmarks and were retained as ECCs: arsenic, cadmium, copper, cyanide, lead, mercury, bis(2-ethylhexyl)phthalate, carbon disulfide, and cis-1,2-DCE (Table 4-87). Tin and methacrylonitrile were retained as ECCs in sediment because no suitable benchmarks were available. No soil contaminants exceeded benchmarks, but acetone and di-n-butyl phthalate were retained as soil ECCs because no suitable benchmarks were available (Table 4-88).

TABLE 4-85

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 3
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values(µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Aluminum	4/4	ND	67.10 - 12,300	87	141.0	Retained - HQ > 1
Antimony	7/9	ND	71.90 - 161	4,300	0.04	Eliminated - does not exceed threshold
Arsenic	8/9	4.33	4.20 - 39.30	50	0.79	Eliminated - does not exceed threshold
Barium	9/10	13.88	10.40 - 226	3.9	57.9	Retained - HQ > 1
Chromium	8/12	4.09	10.10 - 73.50	11	6.68	Retained - HQ > 1
Copper	5/11	ND	10.40 - 91.90	6.54	14.05	Retained - HQ > 1
Manganese	2/3	4.82	42.40 - 62.20	80	0.78	Eliminated - does not exceed threshold
Mercury	3/11	0.08	0.23 - 0.39	0.012	32.5	Retained - HQ > 1
Silver	1/9	ND	22.60	0.07	322.9	Retained - HQ > 1
Tin	1/8	ND	73.6	NA		Retained - no suitable threshold was available
Vanadium	2/10	ND	14.8 - 58.1	19	3.06	Retained - HQ > 1
Zinc	7/10	4.94	5.9 - 45.5	58.9	0.77	Eliminated - does not exceed threshold
PESTICIDE/PCB						
Aldrin	1/8	ND	0.11	0.00014	785	Retained - HQ > 1
Alpha-BHC	1/8	ND	0.35	500	0.0007	Eliminated - does not exceed threshold
Beta-BHC	1/8	ND	1.00	0.046	21.7	Retained - HQ > 1
Delta-BHC	1/8	ND	0.30	500	0.0006	Eliminated - does not exceed threshold
Gamma-BHC (lindane)	1/8	ND	0.75	0.08	9.4	Retained - HQ > 1
Heptachlor	1/8	ND	0.42	0.0038	110.5	Retained - HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
1-methylnapthalene	1/1	ND	33	NA		Retained - no suitable threshold was available
2,4-dimethylphenol	1/9	ND	43	21.2	2.03	Retained - HQ > 1
2-methylnapthalene	4/9	ND	10 - 67	NA		Retained - no suitable threshold was available
Naphthalene	6/14	4.09	4.5 - 114	62	1.84	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS						
1,1-dichloroethane	2/18	ND	2 - 19	2,000	0.01	Eliminated - does not exceed threshold
1,1-dichloroethene	1/18	ND	3.1	3.2	0.90	Eliminated - does not exceed threshold
4-methyl-2-pentanone	1/12	ND	3	NA		Retained - no suitable threshold was available

TABLE 4-85

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 3
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values(µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
VOLATILE ORGANIC COMPOUNDS (cont.)						
Acetone	5/12	5	3 - 46	NA		Retained - no suitable threshold was available
Benzene	2/18	ND	4 - 11	71.28	0.15	Eliminated - does not exceed threshold
Bromomethane	1/18	ND	3	NA		Retained - no suitable threshold was available
Carbon disulfide	7/12	ND	2 - 12	NA		Retained - no suitable threshold was available
Chloroethane	1/18	ND	1	NA		Retained - no suitable threshold was available
Cis-1,2-dichloroethene	2/7	ND	3 - 3.7	NA		Retained - no suitable threshold available
Ethylbenzene	4/18	ND	5 - 15	453	0.03	Eliminated - does not exceed threshold
Iodomethane	1/8	ND	6	NA		Retained - no suitable threshold was available
Methylene chloride	6/18	1.5	2 - 5	1,930	0.00	Eliminated - does not exceed threshold
Toluene	2/18	ND	1 - 2	130	0.02	Eliminated - does not exceed threshold
Trans-1,2-dichloroethene	1/14	ND	6	NA		Retained - no suitable threshold was available
Vinyl acetate	1/12	ND	3	NA		Retained - no suitable threshold was available
Vinyl chloride	2/18	ND	7.1 - 17	NA		Retained - no suitable threshold available
Xylenes (total)	7/17	ND	1 - 17	1.8	9.4	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-86

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE WATER - SWMU 3
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (μg/L)	Range of Detected Values (μg/L)	Ecological Threshold Value (μg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Antimony	3/8	2.9	100 - 111	4,300	0.025	Eliminated - does not exceed threshold
Barium	8/8	9.05	6.7 - 13	10,000	0.0013	Eliminated - does not exceed 2 X background
Copper	3/8	2.05	1.3 - 34.4	2.4	14.3	Retained - HQ > 1
Cyanide	2/6	1.56	36.8 - 62.7	1	62.7	Retained - HQ > 1
Lead	2/8	ND	4.3 - 14.4	5.6	2.57	Retained - HQ > 1
Nickel	2/8	ND	1.6 - 2.2	8.2	0.27	Eliminated - does not exceed threshold
Thallium	6/8	4.88	3.3 - 8.5	6.3	1.35	Eliminated - does not exceed 2 X background
Tin	1/3	ND	126	0.01	12,600	Retained - HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
Fluoranthene	1/3	ND	0.24	370	0.0006	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-87

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 3
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value[(1)]	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	5/5	2,041.75	1,120 - 3,060	NA		Eliminated - does not exceed 2 X background
Arsenic	5/9	1.71	1.3 - 10.25	7.24/70	1.42/0.15	Retained - HQ > 1
Barium	9/9	9.88	5.0 - 12.3	40	0.31	Eliminated - does not exceed 2 X background
Cadmium	5/9	0.42	0.41 - 1.1	0.676/9.6	1.63/0.11	Retained - HQ > 1
Chromium	9/9	6.94	5.2 - 17.4	52.3	0.33	Eliminated - does not exceed threshold
Cobalt	1/9	0.88	0.58	50	0.01	Eliminated - does not exceed 2 X background
Copper	9/9	9.01	8.1 - 163	18.7/270	8.72/0.60	Retained - HQ > 1
Cyanide	2/7	ND	1.8 - 14	0.1	140	Retained - HQ > 1
Lead	9/9	24.65	9.1 - 136	30.2/218	4.5/0.62	Retained - HQ > 1
Manganese	5/5	21.95	9.8 - 22.3	460	0.05	Eliminated - does not exceed 2 X background
Mercury	2/9	ND	0.05 - 0.14	0.13/0.71	1.08/0.20	Retained - HQ > 1
Nickel	5/9	2.49	2.2 - 2.9	15.9	0.18	Eliminated - does not exceed 2 X background
Silver	1/9	ND	0.19	0.733	0.26	Eliminated - does not exceed threshold
Tin	1/4	2.85	18.5	NA		Retained - no suitable threshold was available
Vanadium	6/9	4.84	2.9 - 9.4	NA		Eliminated - does not exceed 2 X background
Zinc	9/9	30.4	28.2 - 88.9	124	0.72	Eliminated - does not exceed threshold
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetone	2/3	34.3	11 - 23	64	0.36	Eliminated - does not exceed threshold
Bis(2-ethylhexyl)phthalate	2/3	2,299	1,400 - 1,600	182/8.9E+08	8.79/1.8E-06	Retained - HQ > 1
Carbon disulfide	1/3	ND	34	13	2.62	Retained - HQ > 1
Cis-1,2-dichloroethene	2/5	ND	19 - 31	23	1.35	Retained - HQ > 1
Methacrylonitrile	1/3	ND	2,700	NA		Retained - no suitable threshold was available
Methylene chloride	3/5	7.6	36 - 48	427	0.11	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.
ND = Not detected.

1 When two values are presented, the left value is the most conservative available and the right value is a less conservative value, if available. In these instances, two HQ values are presented. Contaminants were retained as final ECPCs if the most conservative ET value available was exceeded.

TABLE 4-88

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 3
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold Value (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Aluminum	4/4	2,130	213 - 639	600	1.06	Eliminated - does not exceed 2 X background
Antimony	3/5	0.428	0.24 - 0.29	NA		Eliminated - does not exceed 2 X background
Arsenic	4/5	1.4	0.28 - 0.6	60	0.01	Eliminated - does not exceed 2 X background
Barium	5/5	11	5.1 - 7.3	440	0.02	Eliminated - does not exceed 2 X background
Beryllium	4/5	0.054	0.07 - 0.08	NA		Eliminated - does not exceed 2 X background
Cadmium	4/5	0.173	0.021 - 0.31	20	0.02	Eliminated - does not exceed 2 X background
Chromium	5/5	6.22	2.0 - 3.0	0.4	7.5	Eliminated - does not exceed 2 X background
Cobalt	2/5	0.341	0.14 - 0.17	200	0.0009	Eliminated - does not exceed 2 X background
Copper	4/5	5.2	0.405 - 3.5	50	0.07	Eliminated - does not exceed 2 X background
Lead	1/5	16.8	4.6	500	0.009	Eliminated - does not exceed 2 X background
Manganese	4/4	19.4	2.2 - 8.6	100	0.09	Eliminated - does not exceed 2 X background
Nickel	4/5	1.63	0.43 - 0.78	200	0.004	Eliminated - does not exceed 2 X background
Vanadium	4/5	3.71	1.5 - 2.0	20	0.1	Eliminated - does not exceed 2 X background
Zinc	5/5	19.0	0.75 - 6.6	200	0.03	Eliminated - does not exceed 2 X background
Organics						
Acetone	1/5	3.67	39	NA		Retained - no suitable threshold was available
Di-n-butyl phthalate	2/5	427	91 - 110	NA		Retained - no suitable threshold was available
Methylene chloride	1/5	2.80	27	300	0.09	Eliminated - does not exceed threshold

NA = No suitable ecological threshold value was available.

4.3.8.4.1.3 Toxicity Tests

Survival of amphipods in one of five sediment samples from SWMU 3 was significantly less than in the laboratory controls, and survival in the other four samples was similar to survival in the laboratory controls (Table 4-89). Growth of the amphipods in all five samples from this site was greater than in laboratory controls. The survival of silverside minnows from this site was not significantly different than in laboratory controls.

4.3.8.4.1.4 Tissue Analyses

Four species of fish were collected from the shallow lagoon at SWMU 3. Sailfin mollies, marsh killifish, and sheepshead minnows were all species of minnows that were composited by species into samples of approximately 30 g each. One American eel was collected from SWMU 3. Analytes detected in fish samples collected at SWMU 3 consisted of arsenic, barium, copper, lead, mercury, selenium, silver, zinc, Aroclor-1260 (a PCB), and 4,4'-DDE.

4.3.8.4.2 <u>Discussion</u>

Some metals and organic compounds were present in site groundwater at concentrations that exceeded surface-water benchmarks, but groundwater is not available to ecological receptors. Groundwater could become available to ecological receptors by discharging to surface water or sediment, but groundwater ECCs generally did not match surface-water and sediment ECCs. In addition, groundwater contaminants will be diluted on discharge to the lagoon. Hence, the groundwater-to-surface-water/sediment migration pathway does not appear to represent significant ecological risks at present.

Results of the current screening assessment indicate that no metals or organic compounds in site soils exceeded ecological threshold (ET) values. Two organic compounds were detected for which no ET values were available, but these two compounds were present only at low concentrations. Thus, contaminants in soils at SWMU 3 do not appear to be pose significant ecological risks.

Four metals in surface water were retained as final ECCs, but were present in only a few samples. A few metals and organic compounds slightly exceeded the most conservative available benchmark values in sediment, but did not exceed less conservative values. Cyanide, carbon disulfide, and cis-1,2-DCE exceeded the only sediment benchmark values available for those contaminants. Carbon disulfide and cis-1,2-DCE only slightly exceeded their respective benchmark values, but one of two detected cyanide

TABLE 4-89

TOXICITY TEST RESULTS - SWMU 3
NAS KEY WEST

Test Type and Endpoint	Sample					
	Control	**1**	**2**	**3**	**4**	**5**
Amphipod 10-day sediment toxicity test (% survival) and total growth (mg)	86.3(1)	72.5	62.5*	83.8	78.8	90.0
	0.060(2)	0.084	0.098	0.099	0.073	0.083
Silverside minnow 96-hour toxicity test (% survival)	95	80	85	85	90	95

*Sample result significantly different from control

1 % survival
2 Total growth in milligrams (mg)

values resulted in an HQ of 140. If the ECCs identified in surface water and sediment are present at concentrations that are actually hazardous to aquatic receptors in the lagoon, their effects presumably would be reflected by the toxicity tests and tissue analyses that were conducted on samples collected in the lagoon. A discussion of these tests and analyses follows.

In aquatic toxicity tests of five surface-water samples collected from the lagoon, the survival of silverside minnows was similar to survival of laboratory controls. Survival of amphipods in one of five sediment samples from SWMU 3 was significantly less than in the laboratory controls, but survival in the other four samples was similar to survival in the laboratory controls (Table 4-89). Because amphipod survival in four of five sediment samples was normal, and because growth of the amphipods in all five samples from this site was greater than in laboratory controls, the reduced survival in a single sediment sample does not appear to have been a SWMU-related effect. Thus, the water and sediment toxicity tests show no indication of site-related toxic effects.

Concentrations of lead, mercury, and 4,4'-DDE in fish collected from SWMU 3 were less than in fish collected from background locations and less than concentrations considered to be hazardous to piscivorous receptors. Arsenic concentrations in fish from SWMU 3 were higher than some background fish, but arsenic was detected in only four of 16 sailfin mollies with concentrations ranging from 0.27 to 4.3 mg/kg. An arsenic ET value for piscivorous receptors was not available, but Eisler (1988) noted that arsenic values up to 40 mg/kg in marine finfish are not uncommon. Barium and copper concentrations in sheepshead minnows from SWMU 3 were higher than in sheepshead minnows from background locations, while barium and copper in other species from SWMU 3 were similar to background fish concentrations. Selenium concentrations in fish were similar to those from background locations, except in one sailfin molly sample the selenium concentration was 1.0 mg/kg. This was the only value that exceeded the 0.75 mg/kg benchmark value for selenium. This particular sample (S3F-10) contained the highest values from SWMU 3 for arsenic, selenium, and zinc, and was one of only two samples in which silver was detected. A benchmark value for silver in piscivorous receptors was not available, and silver was not detected in any background sample. Silver was detected in two of 16 sailfin mollies and one of three sheepshead minnow samples from SWMU 3. Due to the low frequency of detection, silver is not believed to pose a significant risk to aquatic receptors. Zinc values from SWMU 3 fish were similar to background samples, except in two sailfin molly samples (S3F-08 at 510 mg/kg, and S3F-10 at 535 mg/kg). In summary, the contaminants detected in SWMU 3 fish were generally present in concentrations similar to those in fish from background locations and did not exceed concentrations considered to be protective of piscivorous receptors.

Concentrations of Aroclor-1260 (the only PCB detected in fish tissue from SWMU 3) were generally higher (especially in sailfin mollies) than in background fish. Concentrations in several samples exceeded the most conservative benchmark available. However, all Aroclor-1260 concentrations were less than the highest benchmark of 3,000 ppb. In addition, the disposal of PCBs at or near SWMU 3 is not known to have occurred, and the source of contamination at SWMU 3 (primarily waste jet fuel) would not be expected to be a source of PCBs.

PCBs are known to be ubiquitous in the environment. Fish collected nationwide and analyzed by the U.S. Fish and Wildlife Service as part of the National Pesticide Monitoring Program contained the following mean values: 892 ppb (1970-1976), 880 ppb (1976-1977), 850 ppb (1978-1979), and 530 ppb (1980-1981) (ATSDR, 1995). All Aroclor concentrations in fish from SWMU 3 were well below those values. Overall, because PCBs were not detected in site soil or sediment, and because the concentrations of PCBs in fish were low in relation to the highest available benchmark, the presence of Aroclor-1260 in fish from SWMU 3 is not believed to pose a significant risk to aquatic receptors.

4.3.8.5 Ecological Risk Assessment Summary

The Phase I ecological screening assessment concluded that the risk to terrestrial receptors at SWMU 3 was "low," and that moderate potential risks appeared to exist to piscivores from ingestion of several different contaminants in prey (IT Corporation, 1994). After the Phase I assessment, soil in the southern burn pit was excavated to bedrock and replaced with clean fill material.

The groundwater-to-surface water/sediment migration pathway does not appear to represent significant ecological risks. Based on a screening assessment of surface water and sediment, and on toxicity tests and tissue analyses, contamination of surface water and sediment is negligible and does not appear to pose a significant risk to aquatic receptors. Based on the lack of terrestrial habitat, and on the results of a soil screening assessment, potential risks to terrestrial receptors on and near SWMU 3 appear to be negligible.

Sampling activities at the site were adequate to characterize potential risks to ecological receptors in the area, and no further sampling or remediation based on ecological risks is warranted.

4.3.9 Conclusions and Recommendations

Metals were the dominant soil and sediment contaminants at SWMU 3; however, they are found at the site in low levels. Arsenic, beryllium, and chromium as well as copper and lead have been found at levels slightly in excess of screening action levels. In addition, a few halogenated and aromatic volatiles and some PAHs are present in groundwater at the site. Thallium was also detected in surface-water samples at low levels.

The estimated carcinogenic risks for future residents (1E-05), adult trespassers (3E-06) and adolescent trespassers (2E-06) are within the EPA's target risk range of 1E-04 to 1E-06. The calculated carcinogenic risks are primarily due to arsenic levels detected in sediment, which are believed to be at levels that are common throughout the lower Florida Keys. The calculated noncarcinogenic risk for the hypothetical future resident slightly exceeds 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated. The primary chemicals contributing to the calculated noncarcinogenic risk (antinomy in surface water and arsenic in sediment) are not believed to be indicators of contamination, but rather, they are indicative of the wide variability inherent in the analytical results.

The ecological risk assessment concluded that potential risks to terrestrial receptors at SWMU 3 are negligible. This is largely because of lack of terrestrial habitat and the low level of contaminants present. In addition, it was concluded that the low levels of contamination present in the surface water and sediment at the site are negligible and do not pose a significant ecological risk to the aquatic receptors.

Based on the lack of human health or ecological risk posed by the site and the lack of significant contamination remaining in excess of screening action levels at SWMU 3, it is recommended that corrective measure studies not be performed and that documentation for a "no further action" decision be prepared.

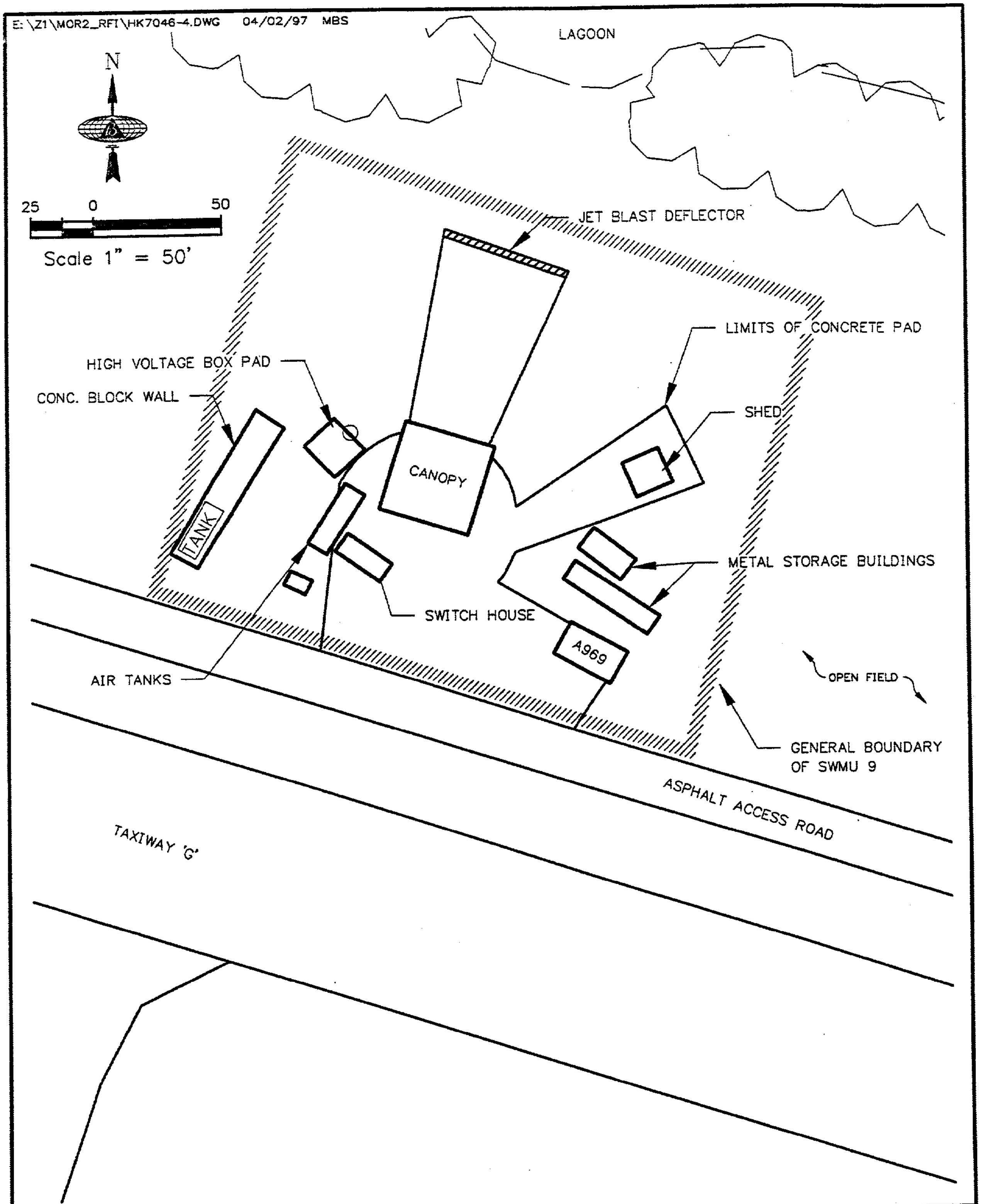
4.4 SWMU 9, BOCA CHICA JET ENGINE TEST CELL, BUILDING A-969

This section presents the site-specific evaluation of data for SWMU 9. It includes a discussion of the site's previous investigation, RFI/RI rationale, site geology and hydrogeology, nature and extent of contamination, contamination fate and transport, baseline human health risk assessment, and ecological risk assessment. Conclusions and recommendations for SWMU 9 are presented in Section 4.4.9.

4.4.1 Unit Description

SWMU 9, the Jet Engine Test Cell site associated with Building A-969, is in the northeastern portion of the Boca Chica Key airfield (Figure 4-36). Beginning in 1969, the site was used for the testing of recently repaired jet engines. No other activities are conducted near the site. Jet engine testing activities were performed under a canopy in the middle of a circular concrete pad approximately 60 feet in diameter in the central part of the site. Jet blast deflectors are located at the ends of two concrete pads (100 feet and 80 feet long, respectively) that connect with the north and northeast portion of the circular concrete pad. The jet engines were fueled from a bermed, 5,000-gallon aboveground storage tank containing JP-5 fuel that was in use from 1987 through 1995. Building A-969 is 50 feet southeast of the testing area. The concrete area that extends east of the canopy was the former jet engine testing area. A small shed at the eastern end of the concrete pad was used for storage of various equipment, oils, and jet fuel. Gas path cleaners were also stored on the eastern side of the shed. An asphalt parking area extends from these structures to the asphalt road. In addition, a switch house, air tanks, voltage box, and the 5,000-gallon aboveground storage tank (AST) for JP-5 fuel are adjacent to the southwestern edge of the circular pad. A strip of mowed grass approximately 30 feet wide surrounds the east and west ends of the site. A narrow strip of red mangroves is located along the shoreline north of the site.

In January 1989, a filter fuel system leak resulted in the release of approximately 700 gallons of JP-5 fuel on the west side of the AST. Approximately 600 gallons of the spilled fuel were recovered from puddles by pumping free product during initial remediation activities. The observed maximum depth of soil contamination was two inches. About 10 cubic yards of contaminated soil were excavated and removed from the spill site, which underwent weathering treatment for decontamination in accordance with State of Florida guidelines for petroleum-contaminated soils. Furthermore, an overturned lubrication oil drum and stained soil in a small area adjacent to the northwest edge of the circular pad were observed by ABB in November 1992 (ABB, 1994).



SITE MANAGER: RD	CHECKED BY: KW	Brown & Root Environmental	FIGURE 4-36
DRAWN BY: TCB	DRAWING DATE: 7/24/96		SITE LOCATION MAP
SURVEYED BY: TCB	SURVEY DATE: 2/21/96		SWMU 9
SCALE: 1" = 50'			NAVAL AIR STATION
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046		BOCA CHICA KEY, FLORIDA

The site is bordered to the south by an asphalt road that parallels a runway and to the east and west by grassy areas. The entire area is flat, open, and covered with grass where it is not paved. An inlet of Florida Bay is located north of the site, approximately 250 feet from the former location of the canopy.

4.4.2 Site-Specific Investigations

This section summarizes the results from investigations that were performed at SWMU 9 through Spring of 1996. Previous investigations are considered to be all investigations that were conducted prior to the Supplemental RFI/RI in January 1996. Current investigations are those investigations that occurred from January through the spring of 1996.

4.4.2.1 Previous Investigations

Section 1.3 summarizes previous investigations conducted at NAS Key West. This section provides more details regarding the investigations conducted prior to January 1996 at SWMU 9. The contamination assessment study was performed by ABB from October 1993 through February 1994 (ABB, 1994) and the delineation sampling was performed by BEI from January through September 1995 (BEI, 1995a). A summary of each of these previous investigations is presented in this section.

4.4.2.1.1 Contamination Assessment

The Contamination Assessment Report (CAR) (ABB, 1994) concluded that areas of excessively contaminated soil, identified by Organic Vapor Analyzer (OVA) headspace techniques at SWMU 9, were assumed to be associated with residual groundwater contamination, not soil contamination. Twenty-four monitoring wells were installed during the investigation (S9MW-1 through S9MW-18, S9MW-19D, S9MW-20D, and S9MW-21 through S9MW-24). The area of excessive soil contamination identified in the CAR generally corresponded to the area of petroleum groundwater contamination. The tidal influence study indicated that significant variations in water table elevations resulting from tidal fluctuations occur at the site. Vertical groundwater movement may spread soil contamination above and below the water table. The high OVA readings in soil slightly above the water table were assumed to be the result of residual groundwater contamination during periods of low water table elevations.

The areal extent of total naphthalenes and total recoverable petroleum hydrocarbons (TRPH) in groundwater exceeding applicable standards appears to be restricted to the center of the site. The vertical extent of total naphthalenes and TRPH in groundwater does not appear to exceed 20 feet BLS.

The areal and vertical extent of cis-1,2-DCE, trans-1,2-DCE, and TCE in groundwater was not adequately assessed in the north and east parts of the site. These compounds appeared to occur in groundwater outside the area of petroleum groundwater contamination.

The occurrence of 1,4-DCB in groundwater did not appear to be persistent at method detection limits because it was detected in only the October 1993 samples.

The presence of trichlorofluoromethane (TCFM) in the October 1993 samples from monitoring wells S9MW-3 and S9MW-5 did not appear to be a concern because TCFM concentrations were well below applied standards, and TCFM was not detected in other samples.

The source of chlorinated compounds in groundwater was not identified.

4.4.2.1.2 <u>Groundwater Evaluation</u>

BEI performed an evaluation of groundwater at SWMU 9 during the Summer of 1995. This groundwater evaluation was performed to characterize the extent of groundwater contamination and evaluate the feasibility of treating groundwater with a pump-and-treat system. The groundwater evaluation field work consisted of groundwater sampling at existing monitoring wells, as well as at 10 hydropunch locations (HY01 through HY10), and a pump test.

The groundwater evaluation report states that the extent of contamination has been completely evaluated (BEI, 1995a). Two wells contained free product, and two other wells had total DCE concentrations above regulatory screening criteria. Other organic compounds were detected below regulatory screening levels.

The results of the pump test indicated that water levels in the underlying aquifer react rapidly to pumping and then stabilize after a short amount of time. Aquifer transmissibility was calculated to be about 9E-03 ft/min, and horizontal groundwater flow velocity was about 50 feet per year. Groundwater was observed to flow toward the inlet. Tidal fluctuations were observed to decrease from 0.5 foot at the shore to 0.2 foot closer to the location of the pump test.

The groundwater evaluation report concludes that conditions at SWMU 9 are favorable for the installation and successful operation of a pump-and-treat system based on data from the groundwater evaluation.

4.4.2.2 Current Investigations

The Supplemental RFI/RI performed by B&R Environmental is the sole current investigation for SWMU 9. Section 4.4.3.1 presents a summary of the scope of work performed at SWMU 9 during the Supplemental RFI/RI.

4.4.3 RCRA Facility Investigation Rationale

This section presents the reasons for conducting the Supplemental RFI/RI activities at SWMU 9. These reasons are presented in two sections. Section 4.4.3.1 discusses the scope of the field work performed in January 1996 and Section 4.4.3.2 discusses analytical parameters that were used.

4.4.3.1 Investigation Scope

Supplemental RFI/RI field activities at SWMU 9 included surface and subsurface soil sampling to assess and further delineate the source area of chlorinated solvents. The Navy Remedial Action Contractor (RAC) installed a pump-and-treat groundwater remediation system after field activities concluded in January 1996. The analytical data generated from the Supplemental RFI/RI were used in conjunction with historical data to support the installation of the groundwater remediation system. Sediment and surface-water samples were collected from the inlet north of the site to support the ecological risk assessment.

4.4.3.2 Analytical Parameters

All SWMU 9 samples were analyzed for the following parameters:

- Appendix IX organics (VOCs, SVOCs, pesticides, and PCBs)
- Herbicides
- TAL metals
- Cyanide

4.4.4 Site Geology and Hydrogeology

The regional geology and hydrogeology of the Florida Keys are presented in Sections 3.4 and 3.5 of this report. The site-specific geology and hydrogeology of the unit were determined from soil borings and from monitoring wells installed during the contamination assessment study, the groundwater evaluation study, and the Supplemental RFI/RI.

4.4.4.1 Geology and Soils

Five soil borings were installed at the site. Split spoon samples were collected continuously for a lithologic description of the subsurface. The naturally occurring oolitic limestone was encountered at the surface and was present to the termination of the borings at 13 feet BLS. The limestone was well consolidated with abundant shell fragments and medium- to fine-grain sand in the limestone matrix. The limestone was consistent in all borings, and no lateral or horizontal variations were apparent. The SPT blow count indicated that the limestone is of medium to high density.

4.4.4.2 Hydrogeology

Twenty-four monitoring wells are present at the site. Monitoring wells were not installed at SWMU 9 during the Supplemental RFI/RI. The oolitic limestone was encountered to the maximum depth of 13 feet BLS that was penetrated on the site. The hydrogeologic unit associated with the oolitic limestone is the surficial aquifer. High conductivity values can be expected at the site due to the salt water inlet to the north. Recharge to the aquifer is directly through rainfall.

Groundwater elevation data collected during the contamination assessment study indicated a predominantly northerly groundwater flow direction, with some tidal influence. Groundwater was reported to be approximately 1 to 3 feet BLS.

Groundwater elevations measured on January 18 and 19, 1996, were consistent with those recorded during the two previous investigations. Groundwater flow was in a north-northeast direction toward the lagoon (see Figure 4-37).

4.4.5 <u>Nature and Extent of Contamination</u>

The nature and extent of contamination were investigated by analyzing samples from surface and subsurface soil, sediment, surface water, and groundwater in the vicinity of the Jet Engine Test Cell. The results of these analyses were compared with the ARARs or SALs that were most restrictive for the given chemical in the given medium. A listing of ARARs and SALs used for each medium is presented in Section 2.3.1. This section focuses primarily on chemicals that exceeded the most conservative ARAR/SAL criteria. The discussion is accompanied by figures which show the concentrations of certain contaminants of interest (COIs). The COIs were selected based on the criteria presented in Appendix G, Section 3.1.3.2. Appendix L contains the analytical data reports for all samples.

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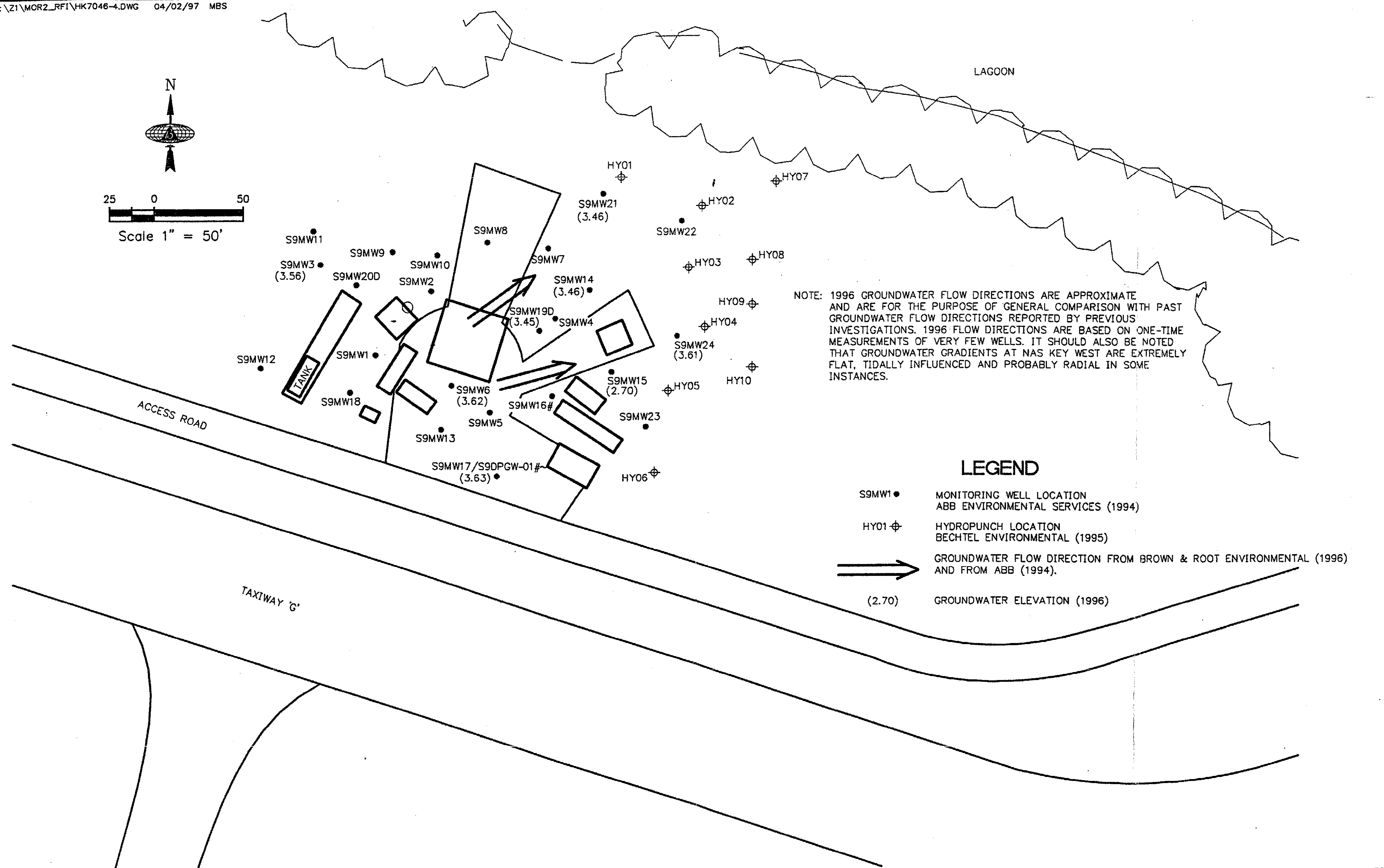


MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-37
GROUNDWATER FLOW AND ELEVATIONS SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.4.5.1 Soil

Aluminum, chromium, and cyanide were the most frequently detected chemicals in the soil at the Jet Engine Test Cell. All soil sampling at SWMU 9 was performed in association with this Supplemental RFI/RI. Five surface soil samples were collected and, in an effort to better characterize the groundwater contamination at the site, five subsurface samples were analyzed (see Tables 4-90 and 4-91). Figure 4-38 shows the extent of surface soil contamination, while Figure 4-39 shows the distribution of subsurface contaminants that exceeded ARARs and SALs in the Supplemental RFI/RI sampling. To be conservative, contaminant levels discussed in this section are compared to the most restrictive criteria from several sets of ARARs/SALs, including ORNL BTVs, EPA BTVs, RCRA Action Levels, RPRGs, FDEP Residential Cleanup Goals, and FDEP Industrial Soil Cleanup Goals. These criteria are shown in Table 2-3.

4.4.5.1.1 Volatile Organic Compounds

No VOCs exceeded an ARAR or SAL in surface soil at the Jet Engine Test Cell. Methylene chloride was the only VOC to exceed an ARAR or SAL in the subsurface soils. This occurred at two locations: S9SB-1, to the east of the above-ground storage tank; and S9SB-2, to the immediate east of the jet engine testing area. Methylene chloride was also detected in groundwater near S9SB-2 during the groundwater evaluation study. In S9SB-2, methylene chloride was detected below the 0.3-mg/kg criteria. At 0.366 mg/kg, the concentration of methylene chloride in S9SB-1 was slightly greater than this ARAR/SAL. Subsurface soil samples were taken around the former testing area to better characterize the trans-1,2-DCE contamination. Low levels of trans-1,2-DCA were detected in two of the samples in the area where groundwater concentrations of DCA were at a maximum.

4.4.5.1.2 Semivolatile Organic Compounds

No SVOCs exceeded the ARAR/SAL criteria in the Supplemental RFI/RI soil samples. Naphthalene was detected in a single sample from the western portion of the site although the concentration was well below the criteria. 2-methylnaphthalene was also detected in the same sample and in another sample from the same part of the site. This is the same area where groundwater concentrations of naphthalene peaked in both the contamination assessments and the groundwater evaluation studies.

TABLE 4-90

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 9
NAS KEY WEST
PAGE 1 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S9SS-5	01/15/96	Aluminum	4,790	
S9SS-4	01/15/96	Aluminum	4,500	
S9SS-1	01/15/96	Aluminum	4,190	
S9SS-2	01/15/96	Aluminum	1,600	
S9SS-3	01/15/96	Aluminum	1,260	
S9DPSS-1	01/15/96	Aluminum	1,080	
S9SS-3	01/15/96	Barium	51.3	
S9DPSS-1	01/15/96	Barium	42.3	
S9SS-1	01/15/96	Barium	27.1	
S9SS-5	01/15/96	Barium	21.1	
S9SS-4	01/15/96	Barium	17.5	
S9SS-2	01/15/96	Barium	14.5	
S9SS-3	01/15/96	Cadmium	7.9	
S9DPSS-1	01/15/96	Cadmium	6.4	
S9SS-1	01/15/96	Cadmium	2.1	
S9SS-2	01/15/96	Calcium	465,000	
S9SS-3	01/15/96	Calcium	408,000	
S9SS-4	01/15/96	Calcium	387,000	
S9DPSS-1	01/15/96	Calcium	331,000	
S9SS-1	01/15/96	Calcium	325,000	
S9SS-5	01/15/96	Calcium	316,000	
S9SS-3	01/15/96	Chromium	124	
S9DPSS-1	01/15/96	Chromium	15.1	
S9SS-1	01/15/96	Chromium	13.1	
S9SS-4	01/15/96	Chromium	11.8	
S9SS-5	01/15/96	Chromium	10.3	
S9SS-2	01/15/96	Chromium	7.2	
S9SS-3	01/15/96	Cobalt	1.4	
S9DPSS-1	01/15/96	Cobalt	1.2	
S9SS-1	01/15/96	Cobalt	0.98	
S9SS-4	01/15/96	Cobalt	0.96	
S9SS-5	01/15/96	Cobalt	0.57	
S9SS-2	01/15/96	Cobalt	0.33	
S9SS-1	01/15/96	Copper	49.6	
S9SS-3	01/15/96	Copper	19.8	
S9DPSS-1	01/15/96	Copper	17.3	
S9SS-4	01/15/96	Copper	13.7	
S9SS-5	01/15/96	Copper	9.1	
S9SS-2	01/15/96	Copper	6.9	
S9SS-4	01/15/96	Cyanide	2.6	J
S9DPSS-1	01/15/96	Cyanide	2.3	J
S9SS-3	01/15/96	Cyanide	2.1	J
S9SS-4	01/15/96	Iron	3,060	
S9SS-3	01/15/96	Iron	2,780	
S9SS-5	01/15/96	Iron	2,680	
S9SS-1	01/15/96	Iron	2,650	
S9DPSS-1	01/15/96	Iron	1,470	
S9SS-2	01/15/96	Iron	1,170	
S9SS-3	01/15/96	Lead	434	
S9DPSS-1	01/15/96	Lead	95.9	
S9SS-1	01/15/96	Lead	71.4	
S9SS-4	01/15/96	Lead	19.1	
S9SS-5	01/15/96	Lead	15.1	
S9SS-2	01/15/96	Lead	7.4	
S9SS-4	01/15/96	Magnesium	6,500	
S9SS-1	01/15/96	Magnesium	6,470	
S9SS-5	01/15/96	Magnesium	5,690	

TABLE 4-90

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 9
NAS KEY WEST
PAGE 2 OF 3

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S9SS-2	01/15/96	Magnesium	2,870	
S9SS-3	01/15/96	Magnesium	2,500	
S9DPSS-1	01/15/96	Magnesium	2,120	
S9SS-4	01/15/96	Manganese	66.4	
S9SS-1	01/15/96	Manganese	37.9	
S9SS-5	01/15/96	Manganese	34.9	
S9SS-3	01/15/96	Manganese	29.4	
S9DPSS-1	01/15/96	Manganese	23.7	
S9SS-2	01/15/96	Manganese	12.4	
S9DPSS-1	01/15/96	Mercury	0.36	
S9SS-3	01/15/96	Mercury	0.28	
S9SS-1	01/15/96	Mercury	0.06	
S9SS-1	01/15/96	Nickel	6.6	
S9SS-4	01/15/96	Nickel	4.9	
S9SS-3	01/15/96	Nickel	4.7	
S9SS-5	01/15/96	Nickel	4.3	
S9SS-2	01/15/96	Nickel	3.6	
S9DPSS-1	01/15/96	Nickel	3.6	
S9SS-4	01/15/96	Potassium	621	
S9SS-5	01/15/96	Potassium	513	
S9SS-1	01/15/96	Potassium	260	
S9SS-2	01/15/96	Potassium	207	
S9SS-3	01/15/96	Potassium	128	
S9DPSS-1	01/15/96	Potassium	106	
S9SS-5	01/15/96	Silver	4.6	
S9SS-1	01/15/96	Silver	1.8	
S9DPSS-1	01/15/96	Silver	1.6	
S9SS-3	01/15/96	Silver	0.72	
S9SS-4	01/15/96	Sodium	2,180	
S9SS-2	01/15/96	Sodium	1,840	
S9SS-1	01/15/96	Sodium	1,310	
S9SS-5	01/15/96	Sodium	988	
S9SS-3	01/15/96	Sodium	855	
S9DPSS-1	01/15/96	Sodium	781	
S9SS-5	01/15/96	Vanadium	14.8	
S9SS-4	01/15/96	Vanadium	12.4	
S9SS-1	01/15/96	Vanadium	10.5	
S9SS-2	01/15/96	Vanadium	8.5	
S9SS-3	01/15/96	Vanadium	5	
S9DPSS-1	01/15/96	Vanadium	3.9	
S9SS-3	01/15/96	Zinc	319	
S9DPSS-1	01/15/96	Zinc	278	
S9SS-1	01/15/96	Zinc	72.2	
S9SS-4	01/15/96	Zinc	55.7	
S9SS-2	01/15/96	Zinc	22.6	
S9SS-5	01/15/96	Zinc	16.5	
PESTICIDES/PCBs (µg/kg)				
S9SS-5	01/15/96	4,4'-DDE	15.1	
S9SS-1	01/15/96	4,4'-DDE	9	
S9SS-2	01/15/96	4,4'-DDT	2.3	
S9SS-5	01/15/96	Endosulfan I	7.9	
S9SS-2	01/15/96	Endrin	5.1	

TABLE 4-90

CONTAMINANTS DETECTED IN SURFACE SOIL AT SWMU 9
NAS KEY WEST
PAGE 3 OF 3

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S9SS-4	01/15/96	Toluene	5	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

TABLE 4-91

CONTAMINANTS DETECTED IN SUBSURFACE SOIL AT SWMU 9
NAS KEY WEST
PAGE 1 OF 2

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S9SB-1	01/17/96	Aluminum	289	
S9DPSB-1	01/17/96	Aluminum	255	
S9SB-4	01/17/96	Aluminum	179	
S9SB-2	01/17/96	Barium	9.1	
S9DPSB-1	01/17/96	Barium	8.9	
S9SB-1	01/17/96	Barium	8	
S9SB-3	01/17/96	Barium	7	
S9SB-4	01/17/96	Barium	6.1	
S9SB-5	01/17/96	Barium	6.1	
S9SB-4	01/17/96	Calcium	407,000	
S9SB-3	01/17/96	Calcium	398,000	
S9SB-5	01/17/96	Calcium	398,000	
S9DPSB-1	01/17/96	Calcium	390,000	
S9SB-2	01/17/96	Calcium	389,000	
S9SB-1	01/17/96	Calcium	383,000	
S9SB-5	01/17/96	Chromium	4.9	
S9DPSB-1	01/17/96	Chromium	4.7	
S9SB-4	01/17/96	Chromium	3.1	
S9SB-1	01/17/96	Chromium	2.3	
S9SB-2	01/17/96	Chromium	2.2	
S9SB-3	01/17/96	Chromium	2.1	
S9SB-3	01/17/96	Cyanide	4.4	
S9SB-2	01/17/96	Cyanide	1.5	J
S9DPSB-1	01/17/96	Iron	457	
S9SB-1	01/17/96	Iron	133	
S9SB-4	01/17/96	Iron	98.1	
S9SB-2	01/17/96	Iron	47.6	
S9SB-5	01/17/96	Iron	44.5	
S9SB-3	01/17/96	Iron	31.9	
S9SB-1	01/17/96	Lead	2.3	
S9DPSB-1	01/17/96	Lead	2.2	
S9SB-5	01/17/96	Lead	1.7	
S9SB-2	01/17/96	Lead	1.4	
S9SB-4	01/17/96	Lead	1.4	
S9SB-3	01/17/96	Lead	1.3	
S9DPSB-1	01/17/96	Magnesium	1,870	
S9SB-1	01/17/96	Magnesium	1,250	
S9SB-4	01/17/96	Magnesium	1,180	
S9SB-5	01/17/96	Magnesium	948	
S9SB-3	01/17/96	Magnesium	829	
S9SB-2	01/17/96	Magnesium	672	
S9DPSB-1	01/17/96	Manganese	5.2	
S9SB-4	01/17/96	Manganese	3.4	
S9SB-2	01/17/96	Manganese	3.2	
S9SB-1	01/17/96	Manganese	2.9	
S9SB-5	01/17/96	Manganese	1	
S9SB-3	01/17/96	Manganese	0.63	
S9SB-5	01/17/96	Nickel	2.1	
S9DPSB-1	01/17/96	Nickel	1.8	
S9SB-4	01/17/96	Nickel	1.1	
S9SB-2	01/17/96	Nickel	0.76	
S9SB-1	01/17/96	Nickel	0.59	
S9SB-3	01/17/96	Nickel	0.53	
S9SB-1	01/17/96	Potassium	37.7	
S9DPSB-1	01/17/96	Potassium	34.4	
S9SB-5	01/17/96	Potassium	32.2	
S9SB-3	01/17/96	Potassium	32	

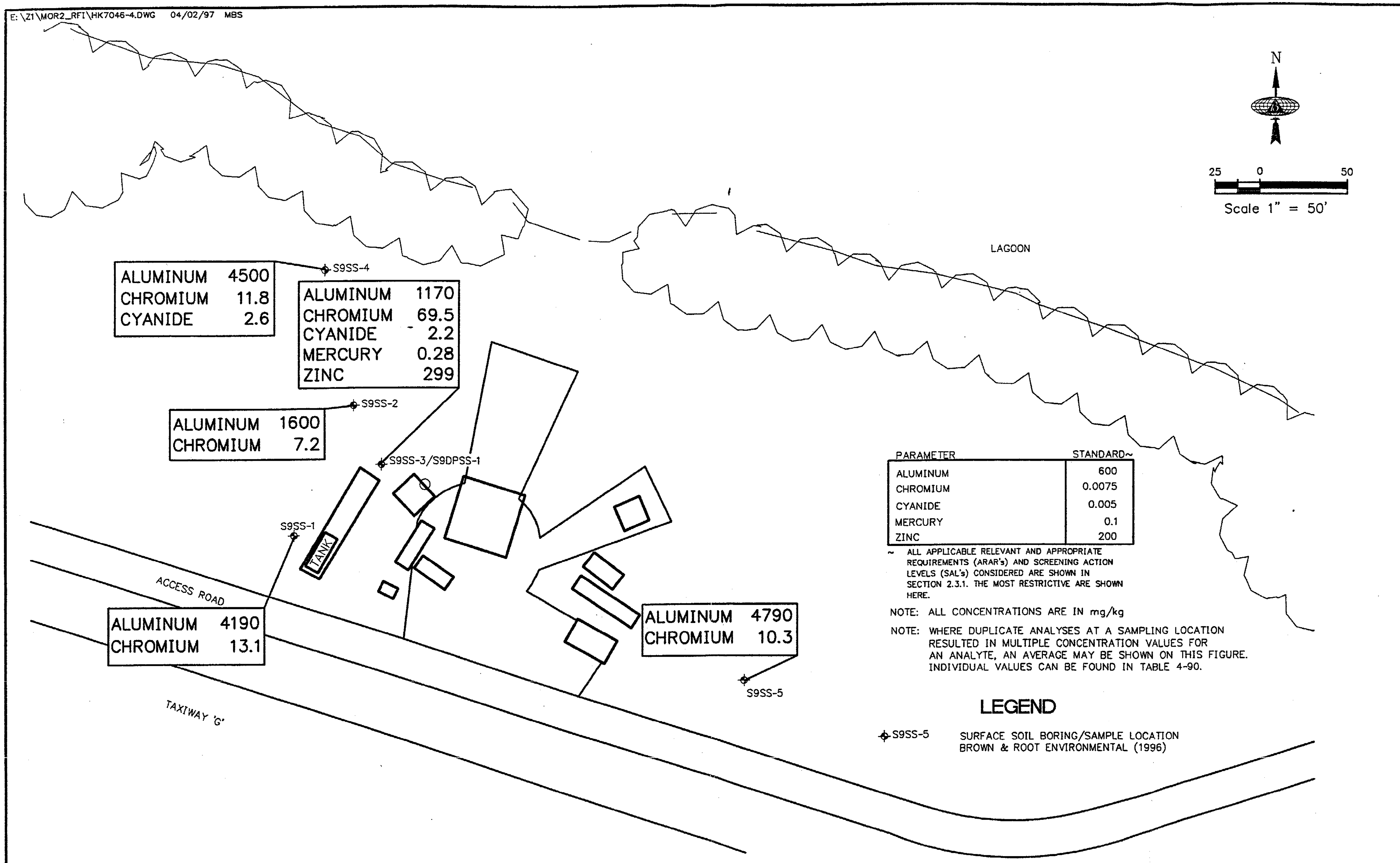
TABLE 4-91

CONTAMINANTS DETECTED IN SUBSURFACE SOIL AT SWMU 9
NAS KEY WEST
PAGE 2 OF 2

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S9SB-4	01/17/96	Potassium	29.3	
S9SB-2	01/17/96	Potassium	25.2	
S9SB-3	01/17/96	Silver	0.76	
S9SB-4	01/17/96	Silver	0.31	
S9SB-2	01/17/96	Silver	0.22	
S9SB-2	01/17/96	Sodium	1,530	
S9SB-1	01/17/96	Sodium	1,390	
S9SB-3	01/17/96	Sodium	1,290	
S9DPSB-1	01/17/96	Sodium	1,260	
S9SB-5	01/17/96	Sodium	1,260	
S9SB-4	01/17/96	Sodium	955	
S9DPSB-1	01/17/96	Vanadium	4.3	
S9SB-1	01/17/96	Vanadium	1.5	
S9SB-4	01/17/96	Vanadium	1.4	
S9SB-2	01/17/96	Vanadium	0.71	
S9SB-5	01/17/96	Vanadium	0.52	
S9SB-3	01/17/96	Vanadium	0.43	
PESTICIDES/PCBs (µg/kg)				
S9DPSB-1	01/17/96	4,4'-DDT	5.4	
S9DPSB-1	01/17/96	Delta-BHC	1.7	J
S9DPSB-1	01/17/96	Endrin	1.9	J
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)				
S9SB-1	01/17/96	2-methylnaphthalene	2,570	
S9DPSB-1	01/17/96	2-methylnaphthalene	1,560	
S9SB-1	01/17/96	Naphthalene	960	J
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S9DPSB-1	01/17/96	Acetone	2,430	J
S9SB-5	01/17/96	Acetone	64	
S9SB-4	01/17/96	Acetone	18	
S9SB-3	01/17/96	Acetone	12	
S9DPSB-1	01/17/96	Methylene chloride	672	J
S9SB-2	01/17/96	Methylene chloride	171	J
S9SB-1	01/17/96	Methylene chloride	59	J
S9SB-5	01/17/96	Trans-1,2-dichloroethene	10	
S9SB-3	01/17/96	Trans-1,2-dichloroethene	3	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-3).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.



PARAMETER	STANDARD~
ALUMINUM	600
CHROMIUM	0.0075
CYANIDE	0.005
MERCURY	0.1
ZINC	200

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-90.

LEGEND

S9SS-5 — SURFACE SOIL BORING/SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

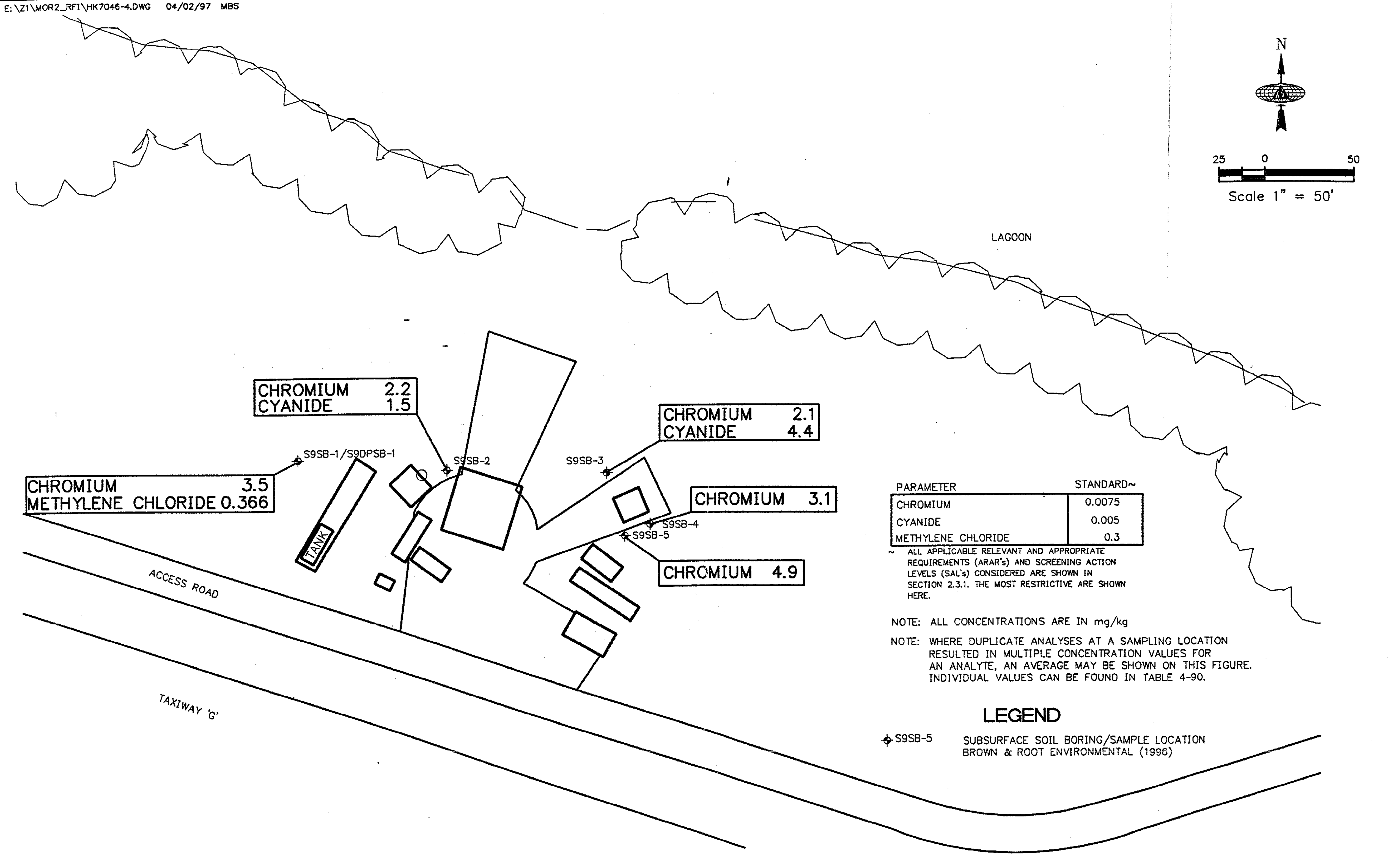
SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-38
SURFACE SOIL CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

0090EB182

E:\Z1\MOR2_RFI\HK7046-4.DWG 04/02/97 MBS



PARAMETER	STANDARD~
CHROMIUM	0.0075
CYANIDE	0.005
METHYLENE CHLORIDE	0.3

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-90.

LEGEND

S9SB-5 SUBSURFACE SOIL BORING/SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-39
SUBSURFACE SOIL CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.4.5.1.3 Pesticides

No pesticides were detected above the ARAR/SAL criteria. Low concentrations of 4,4'-DDT, 4,4'-DDE, delta-BHC, and endrin were found in soils east of the aboveground storage tank, in the same general area where pesticide groundwater contamination was detected during the Supplemental RFI/RI. Low levels of endosulfan I and 4,4'-DDE were found in a surface soil sample east of the concrete testing pad.

4.4.5.1.4 PCBs

No PCBs were detected in the soil at SMWU 9.

4.4.5.1.5 Metals and Inorganics

In general, inorganic concentrations were highest in the three corners of the site (southwest, southeast, and northwest) where surface samples were taken. Aluminum, chromium, lead, cyanide, mercury, and zinc were detected above their respective ARAR/SAL criteria. Chromium was the most frequently detected contaminant and was found in all surface and subsurface soil samples. Aluminum exceeded its 600-mg/kg ARAR/SAL at all 5 of the surface sampling locations. In general, metal concentrations were highest in samples from the western half of the site. The maximum cyanide concentration (2.6 mg/kg) occurred at S9SS-4, the most northwesterly point sampled. The aluminum concentration was 4,500 mg/kg at this location, the second highest concentration observed at the site. Chromium was also present in S9SS-4 at a fairly high concentration but was at a maximum (13.1 mg/kg) in the southwest corner of the site near the access road. S9SS-5 (also near the access road, but to the east of the concrete pad) had the highest aluminum concentration at 4,790 mg/kg. Other points in the eastern portion of the site exhibited metal contamination but not to the same degree observed in S9SS-5 and the western samples. These eastern sampling locations produced subsurface samples as opposed to a majority of surface samples in the west. As a result, it is difficult to conclude if the trend of higher levels in the western portion of SWMU 9 represents a true difference in the extent of contamination or if contamination is geographically widespread in the surface soils. Mercury (0.28 mg/kg), lead (434 mg/kg), and zinc (299 mg/kg) exhibited maximum concentrations in S9SS-3, directly to the northeast of the above-ground storage tank containment area. This is also the only point where lead and zinc exceeded their most conservative ARAR or SAL.

4.4.5.2 Sediment

To be conservative, contaminant levels discussed in this section were compared to the most restrictive of several ARARs/SALs, including Florida Sediment Quality Guidelines, EPA Region IV Sediment Screening Values, Federal Sediment Quality Criteria, RCRA Action Levels, ER-L, ER-M, and EPA SQB. These criteria are all shown in Table 2-4.

Contaminants detected in the sediment at SWMU 9 are listed in Table 4-92. Inorganics were the dominant contaminant found in sediment samples from the inlet located on the northern boundary of the Jet Engine Test Cell. However, fewer inorganic compounds were found in sediment samples than in soil samples as discussed above, and the chemicals that were found appeared to be less widespread than those found in soil. As shown in Figure 4-40, most of the sediment contamination appears to be limited to the shoreline due north and northeast of the jet blast deflectors.

4.4.5.2.1 Volatile Organic Compounds

Acetone was the only VOC detected in the sediment samples. It was detected in two of five samples, S9SD-4 and S9SD-5, which were the most easterly locations sampled. In both instances, it exceeded the most conservative ARAR or SAL, which, in this case, is the RCRA Action Level of 0.064 mg/kg. The highest concentration, 1.89 mg/kg, was detected at the most eastward sampling site, S9SD-5.

4.4.5.2.2 Semivolatile Organic Compounds

No SVOCs were detected at any of the five locations where samples were taken.

4.4.5.2.3 Pesticides

Two pesticides were detected in excess of ARAR/SAL criteria in sediment at SWMU 9. 4,4'-DDE was detected in two samples, with the maximum (14.3 µg/kg) occurring at S9SD-02. Delta-BHC was also detected in excess of ARAR/SAL criteria in two samples, but its maximum concentration (14.2 µg/kg) occurred at S9SD-04. Methyl parathion was detected in two samples, but did not exceed ARAR/SAL criteria.

4.4.5.2.4 PCBs

No PCBs were detected in the sediment at SMWU 9.

TABLE 4-92

CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 9
NAS KEY WEST
PAGE 1 OF 2

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg)				
S9SD-03	01/23/96	Aluminum	3,710	
S9SD-05	01/23/96	Aluminum	3,570	
S9SD-01	01/23/96	Aluminum	2,120	
S9SD-02	01/23/96	Aluminum	1,630	
S9SD-04	01/23/96	Aluminum	774	
S9SD-03	01/23/96	Arsenic	17.8	
S9SD-05	01/23/96	Arsenic	12.6	
S9SD-03	01/23/96	Barium	19.8	
S9SD-05	01/23/96	Barium	10.5	
S9SD-01	01/23/96	Barium	8.5	
S9SD-02	01/23/96	Barium	6.7	
S9SD-04	01/23/96	Barium	5.7	
S9SD-05	01/23/96	Cadmium	0.62	
S9SD-03	01/23/96	Cadmium	0.52	
S9SD-02	01/23/96	Cadmium	0.28	
S9SD-01	01/23/96	Calcium	209,000	
S9SD-03	01/23/96	Calcium	183,000	
S9SD-05	01/23/96	Calcium	176,000	
S9SD-02	01/23/96	Calcium	165,000	
S9SD-04	01/23/96	Calcium	130,000	
S9SD-03	01/23/96	Chromium	11.6	
S9SD-05	01/23/96	Chromium	10.4	
S9SD-01	01/23/96	Chromium	6.4	
S9SD-02	01/23/96	Chromium	5.8	
S9SD-04	01/23/96	Chromium	3.3	
S9SD-03	01/23/96	Copper	14.7	
S9SD-04	01/23/96	Copper	14.3	
S9SD-05	01/23/96	Copper	12.8	
S9SD-02	01/23/96	Copper	7.9	
S9SD-01	01/23/96	Copper	4.7	
S9SD-05	01/23/96	Cyanide	12.1	J
S9SD-03	01/23/96	Iron	2,680	
S9SD-05	01/23/96	Iron	2,620	
S9SD-01	01/23/96	Iron	1,380	
S9SD-02	01/23/96	Iron	1,170	
S9SD-04	01/23/96	Iron	762	
S9SD-03	01/23/96	Lead	23.1	
S9SD-05	01/23/96	Lead	21.1	
S9SD-02	01/23/96	Lead	10.4	
S9SD-01	01/23/96	Lead	9.5	
S9SD-04	01/23/96	Lead	6.4	
S9SD-05	01/23/96	Magnesium	11,500	
S9SD-03	01/23/96	Magnesium	11,300	
S9SD-01	01/23/96	Magnesium	9,230	
S9SD-02	01/23/96	Magnesium	8,970	
S9SD-04	01/23/96	Magnesium	7,600	
S9SD-05	01/23/96	Manganese	17.1	
S9SD-03	01/23/96	Manganese	15.3	
S9SD-01	01/23/96	Manganese	11.8	
S9SD-02	01/23/96	Manganese	9.5	
S9SD-04	01/23/96	Manganese	6.2	
S9SD-01	01/23/96	Mercury	1.1	
S9SD-03	01/23/96	Nickel	5	
S9SD-05	01/23/96	Nickel	4.3	
S9SD-02	01/23/96	Nickel	3.2	
S9SD-01	01/23/96	Nickel	1.8	
S9SD-04	01/23/96	Nickel	1.5	

TABLE 4-92

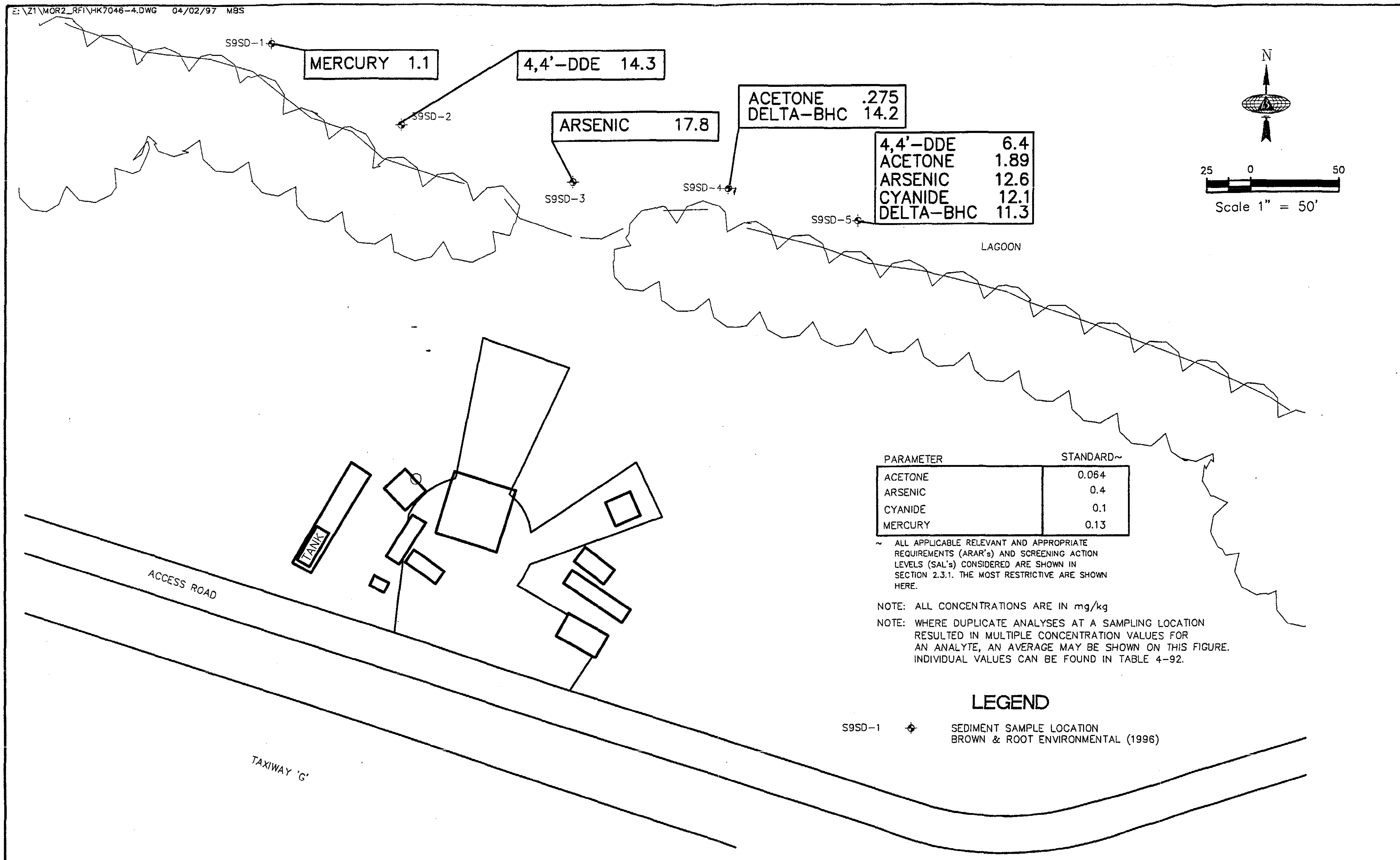
CONTAMINANTS DETECTED IN SEDIMENT AT SWMU 9
NAS KEY WEST
PAGE 2 OF 2

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (mg/kg) (cont.)				
S9SD-03	01/23/96	Potassium	2,740	
S9SD-05	01/23/96	Potassium	2,500	
S9SD-02	01/23/96	Potassium	1,220	
S9SD-04	01/23/96	Potassium	1,110	
S9SD-01	01/23/96	Potassium	1,040	
S9SD-03	01/23/96	Selenium	7.3	
S9SD-05	01/23/96	Sodium	52,400	
S9SD-03	01/23/96	Sodium	52,000	
S9SD-02	01/23/96	Sodium	26,100	
S9SD-04	01/23/96	Sodium	24,800	
S9SD-01	01/23/96	Sodium	20,400	
S9SD-05	01/23/96	Vanadium	13.2	
S9SD-03	01/23/96	Vanadium	12.8	
S9SD-01	01/23/96	Vanadium	6.5	
S9SD-02	01/23/96	Vanadium	6.4	
S9SD-04	01/23/96	Vanadium	4.7	
S9SD-03	01/23/96	Zinc	38.3	
S9SD-05	01/23/96	Zinc	35	
S9SD-04	01/23/96	Zinc	16.5	
S9SD-02	01/23/96	Zinc	14	
S9SD-01	01/23/96	Zinc	12.5	
PESTICIDES/PCBs (µg/kg)				
S9SD-02	01/23/96	4,4'-DDE	14.3	J
S9SD-05	01/23/96	4,4'-DDE	6.4	J
S9SD-04	01/23/96	Delta-BHC	14.2	
S9SD-05	01/23/96	Delta-BHC	11.3	
S9SD-04	01/23/96	Methyl parathion	38.8	J
S9SD-03	01/23/96	Methyl parathion	14.8	J

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/kg)				
S9SD-05	01/23/96	Acetone	1,890	J
S9SD-04	01/23/96	Acetone	275	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-4).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.



PARAMETER	STANDARD~
ACETONE	0.064
ARSENIC	0.4
CYANIDE	0.1
MERCURY	0.13

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN mg/kg

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-92.

LEGEND

S9SD-1 ⌖ SEDIMENT SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-40
SEDIMENT CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

4.4.5.2.5 Metals and Inorganics

Arsenic, cyanide, and mercury exceeded ARAR/SAL criteria for sediment. Cyanide and mercury were also seen in soil samples and surface water, while arsenic was not found in any other medium. The highest arsenic concentration, 17.8 mg/kg, was detected in the sample taken directly north of the current jet blast deflectors. It was also found in the most eastward sample, S9SD-5, which was also the only sample in which cyanide was identified (12.1 mg/kg). Mercury occurred at a concentration of 1.1 mg/kg in a single sample (S9SD-1), from the most westward sampling location.

4.4.5.3 Surface Water

Metals were the only class of compounds that were frequently detected in surface water samples, and, with a single exception, were the only compounds detected in this medium (see Table 4-93). FDEP Surface Water Criteria, EPA Surface Water Criteria, National Surface Water Criteria, and Region III Marine and Fresh Water Criteria were all considered as ARARs/SALs to be conservative. The most restrictive criteria were compared to each chemical concentration discussed in this section. These criteria are shown in Table 2-5.

4.4.5.3.1 Volatile Organic Compounds

No VOCs were detected in surface water from the inlet north of the Jet Engine Test Cell.

4.4.5.3.2 Semivolatile Organic Compounds

No SVOCs were detected in surface water from the inlet north of the Jet Engine Test Cell.

4.4.5.3.3 Pesticides

A single pesticide (2,4-D) was detected at low levels at the most easterly surface water sampling location. However, these levels were well below the most restrictive ARAR/SAL for this compound.

4.4.5.3.4 PCBs

No PCBs were detected in the surface water at SMWU-9.

TABLE 4-93

CONTAMINANTS DETECTED IN SURFACE WATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
HERBICIDES (µg/L)				
S9SW-05	01/23/96	2,4-D	0.13	J
INORGANICS (µg/L)				
S9SW-01	01/23/96	Antimony	5.3	
S9DPSW-01	01/23/96	Antimony	4.2	
S9SW-04	01/23/96	Antimony	3.7	
S9SW-02	01/23/96	Antimony	3.6	
S9SW-05	01/23/96	Antimony	3.2	
S9SW-03	01/23/96	Antimony	2.9	
S9DPSW-01	01/23/96	Barium	7.3	
S9SW-03	01/23/96	Barium	7	
S9SW-02	01/23/96	Barium	6.8	
S9SW-04	01/23/96	Barium	6.8	
S9SW-05	01/23/96	Barium	6.8	
S9SW-01	01/23/96	Barium	6.7	
S9DPSW-01	01/23/96	Calcium	346,000	
S9SW-04	01/23/96	Calcium	344,000	
S9SW-03	01/23/96	Calcium	343,000	
S9SW-05	01/23/96	Calcium	342,000	
S9SW-02	01/23/96	Calcium	333,000	
S9SW-01	01/23/96	Calcium	309,000	
S9SW-04	01/23/96	Cobalt	1.1	
S9SW-01	01/23/96	Cyanide	45.2	
S9SW-03	01/23/96	Magnesium	1,220,000	
S9SW-05	01/23/96	Magnesium	1,180,000	
S9SW-01	01/23/96	Magnesium	1,170,000	
S9SW-02	01/23/96	Magnesium	1,170,000	
S9SW-04	01/23/96	Magnesium	1,170,000	
S9DPSW-01	01/23/96	Magnesium	1,160,000	
S9SW-03	01/23/96	Mercury	0.13	
S9SW-04	01/23/96	Nickel	1.6	
S9SW-03	01/23/96	Potassium	364,000	
S9SW-05	01/23/96	Potassium	353,000	
S9SW-01	01/23/96	Potassium	352,000	
S9SW-04	01/23/96	Potassium	352,000	
S9SW-02	01/23/96	Potassium	351,000	
S9DPSW-01	01/23/96	Potassium	351,000	
S9SW-03	01/23/96	Sodium	10,300,000	
S9SW-04	01/23/96	Sodium	9,980,000	
S9SW-05	01/23/96	Sodium	9,970,000	
S9SW-01	01/23/96	Sodium	9,910,000	
S9DPSW-01	01/23/96	Sodium	9,900,000	
S9SW-02	01/23/96	Sodium	9,860,000	
S9DPSW-01	01/23/96	Thallium	10.1	
S9SW-04	01/23/96	Thallium	10	
S9SW-01	01/23/96	Thallium	9.5	
S9SW-02	01/23/96	Thallium	8.4	
S9SW-05	01/23/96	Thallium	8.1	
S9SW-03	01/23/96	Thallium	5.6	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-4).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.

4.4.5.3.5 Metals and Inorganics

As shown in Figure 4-41, three metallic/inorganic compounds exceeded ARAR/SAL criteria in surface water. Thallium (which exceeded the 6.3 μg/L FDEP criteria in four of the five samples) presented the most widespread contamination; however, in all cases, the concentrations were only slightly greater than the ARAR/SAL. Cyanide and mercury were each detected at a single location. Mercury was detected at a concentration of 0.13 μg/L in surface water due north of the jet blast deflectors at S9SW-3. Cyanide exceeded its 1 μg/L ARAR/SAL at the most westward sampling location, where it was found at a concentration of 45.2 μg/L.

4.4.5.4 Groundwater

Although the groundwater underlying the site is designated G-III (nonpotable), SDWA MCLs, Florida MCLs, FDEP Guidance Concentrations, and RCRA Action Levels were all considered as ARARs/SALs to be conservative. The most restrictive criteria were used in evaluating the nature and extent of groundwater contamination in this section, and those criteria are shown in Table 2-6.

Contaminants detected in groundwater at SWMU 9 are listed in Table 4-94. With the exception of 1,2-DCE (total), the magnitude and extent of groundwater contamination at the Jet Engine Test Cell appears to have greatly diminished over time. Figures 4-42, 4-43 and 4-44 show the chemical concentrations in groundwater that exceeded ARARs and SALs in the contamination assessment, the groundwater evaluation, and the Supplemental RFI/RI, respectively.

4.4.5.4.1 Volatile Organic Compounds

The majority of compounds detected in groundwater were VOCs. Benzene, ethylbenzene, 1,2-DCE (total), and TCE were all identified in the contamination assessment study. As shown by the isopleths in Figure 4-42, the maximum benzene concentration was 56 μg/L at S9MW-5, with a plume extending to the northeast. A benzene plume is also identified in Figure 4-43, based on data obtained from the groundwater evaluation study. The maximum concentration (55.2 μg/L) is very similar to levels observed during the contamination assessment but occurs at S9MW-23 to the east of the maximum level detected during the contamination assessment study, with a plume extending to the northwest. The difference in plume spread from year to year can be explained by seasonal and tidal influences on groundwater movement. During the Supplemental RFI/RI, benzene (4 μg/L) was detected in only one well (S9MW-24) where it was detected on both previous occasions. The maximum ethylbenzene concentration (70 μg/L)

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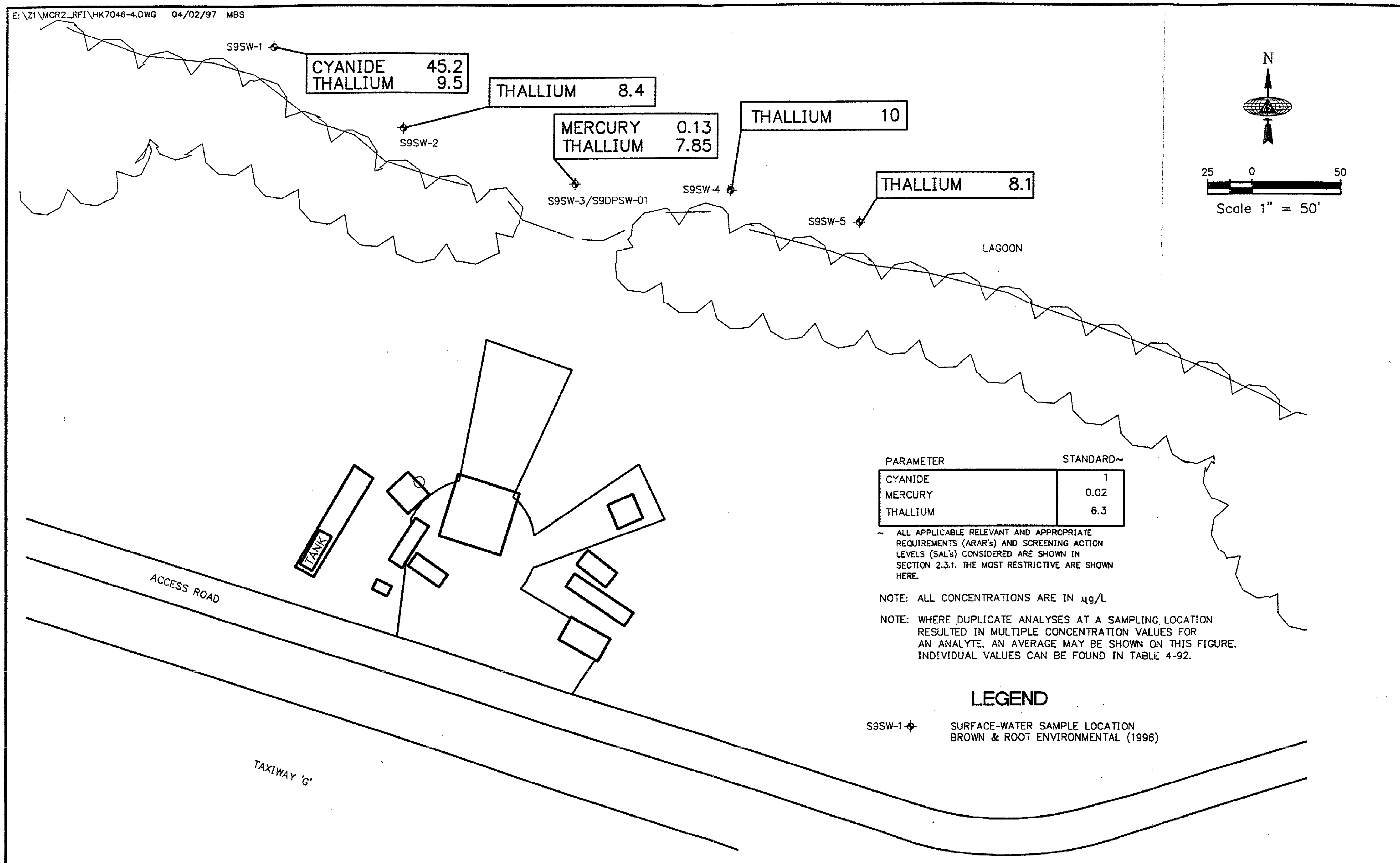


PARAMETER	STANDARD~
CYANIDE	1
MERCURY	0.02
THALLIUM	6.3

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN µg/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-92.

LEGEND

S9SW-1 — SURFACE-WATER SAMPLE LOCATION BROWN & ROOT ENVIRONMENTAL (1996)

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-41
SURFACE-WATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST
PAGE 1 OF 8

Location	Date	Parameter	Result	Qual.(1)
INORGANICS (µg/L)				
S9MW 3	01/18/96	Arsenic	7.6	
S9MW 9	01/18/96	Arsenic	5.3	
S9MW 17	01/18/96	Arsenic	5.075	
S9MW 24	01/18/96	Barium	11.7	
S9MW 3	01/18/96	Barium	9.3	
S9MW 17	01/18/96	Barium	8.05	
S9MW 21	01/18/96	Barium	7.8	
S9MW 6	01/18/96	Barium	7.7	
S9MW 19D	01/18/96	Barium	5.6	
S9MW 15	01/18/96	Barium	5.5	
S9MW 9	01/18/96	Barium	5.4	
S9MW 21	01/18/96	Calcium	198,000	
S9MW 17	01/18/96	Calcium	189,000	
S9MW 24	01/18/96	Calcium	166,000	
S9MW 19D	01/18/96	Calcium	94,600	
S9MW 9	01/18/96	Calcium	75,300	
S9MW 3	01/18/96	Calcium	69,000	
S9MW 15	01/18/96	Calcium	67,000	
S9MW 6	01/18/96	Calcium	61,900	
S9MW 6	01/18/96	Cyanide	6.6	
S9MW 17	01/18/96	Cyanide	1.45	
S9MW 19D	01/18/96	Cyanide	0.89	
S9MW 24	01/18/96	Cyanide	0.88	
S9MW 15	01/18/96	Cyanide	0.83	
S9MW 3	01/18/96	Iron	360	
S9MW 15	01/18/96	Iron	196	
S9MW 9	01/18/96	Lead	2.4	
S9MW 21	01/18/96	Magnesium	377,000	
S9MW 24	01/18/96	Magnesium	195,000	
S9MW 19D	01/18/96	Magnesium	139,000	
S9MW 9	01/18/96	Magnesium	79,400	

Location	Date	Parameter	Result	Qual.(1)
S9MW 6	01/18/96	Magnesium	68,600	
S9MW 3	01/18/96	Magnesium	43,500	
S9MW 15	01/18/96	Magnesium	41,500	
S9MW 17	01/18/96	Magnesium	24,150	
S9MW 21	01/18/96	Manganese	8.5	
S9MW 9	01/18/96	Manganese	5.3	
S9MW 3	01/18/96	Manganese	5	
S9MW 15	01/18/96	Manganese	2.1	
S9MW 17	01/18/96	Manganese	1.04	
S9MW 6	01/18/96	Manganese	0.97	
S9MW 21	01/18/96	Potassium	142,000	
S9MW 19D	01/18/96	Potassium	58,100	
S9MW 24	01/18/96	Potassium	57,000	
S9MW 9	01/18/96	Potassium	23,000	
S9MW 6	01/18/96	Potassium	15,200	
S9MW 15	01/18/96	Potassium	12,300	
S9MW 3	01/18/96	Potassium	9,380	
S9MW 17	01/18/96	Potassium	270	
S9MW 15	01/18/96	Selenium	6	
S9MW 24	01/18/96	Selenium	4.9	
S9MW 3	01/18/96	Silver	6	
S9MW 21	01/18/96	Sodium	3,290,000	
S9MW 24	01/18/96	Sodium	1,410000	
S9MW 19D	01/18/96	Sodium	1,130,000	
S9MW 9	01/18/96	Sodium	471,000	
S9MW 3	01/18/96	Sodium	235,000	
S9MW 15	01/18/96	Sodium	161,000	
S9MW 6	01/18/96	Sodium	116,000	
S9MW 17	01/18/96	Sodium	43,400	
S9MW 3	01/18/96	Vanadium	4.4	
S9MW 24	01/18/96	Vanadium	0.93	
S9MW 9	01/18/96	Vanadium	0.89	

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
PESTICIDIES/PCBs (µg/L)				
S9MW 3	01/18/96	4,4'-DDT	0.26	J
S9MW 24	01/18/96	Beta-BHC	0.029	
S9MW 3	01/18/96	Delta-BHC	0.43	
S9MW 3	01/18/96	Dieldrin	0.19	J
S9MW 3	01/18/96	Endrin	0.25	J
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)				
S9MW 1	10/93	1,4-dichlorobenzene	2	
S9MW 15	10/93	1,4-dichlorobenzene	2	
S9MW 16	10/93	1,4-dichlorobenzene	2	
S9MW 4	10/93	1,4-dichlorobenzene	2	
S9MW 5	10/93	1,4-dichlorobenzene	2	
S9MW 11	10/93	1,4-dichlorobenzene	1	
S9MW 17	10/93	1,4-dichlorobenzene	1	
S9MW 20D	10/93	1,4-dichlorobenzene	1	
S9MW 3	10/93	1,4-dichlorobenzene	1	
S9MW 5	10/93	1-methylnaphthalene	110	
S9MW 2	10/93	1-methylnaphthalene	59	
S9MW 4	10/93	1-methylnaphthalene	55	
S9MW 3	10/93	1-methylnaphthalene	19	
S9MW 10	10/93	1-methylnaphthalene	10	
S9MW 5	10/93	2-methylnaphthalene	130	
S9MW 2	10/93	2-methylnaphthalene	57	
S9MW 4	10/93	2-methylnaphthalene	53	
S9MW 17	01/18/96	Bis(2-ethylhexyl)phthalate	9	
S9MW 2	06/28/95	Chlorodibromomethane	13.5	
S9MW 16	06/28/95	Chlorodibromomethane	2	X
S9MW 18	06/28/95	Chlorodibromomethane	2	X
S9MW 19D	06/28/95	Chlorodibromomethane	2	X
S9MW 23	06/27/95	Chlorodibromomethane	2	X
S9MW 6	06/27/95	Chlorodibromomethane	2	X
S9MW 8	06/28/95	Chlorodibromomethane	2	X

Location	Date	Parameter	Result	Qual.(1)
HY03	07/25/95	Chlorodibromomethane	0.324	JB
S9MW 2	10/93	Naphthalene	110	
S9MW 5	10/93	Naphthalene	100	
HY03	07/25/95	Naphthalene	91.1	
S9MW 4	10/93	Naphthalene	79	
S9MW 2	06/28/95	Naphthalene	67.55	
S9MW 17	06/28/95	Naphthalene	19.1	
S9MW 10	06/28/95	Naphthalene	18.8	
S9MW 16	06/28/95	Naphthalene	10.8	
S9MW 10	10/93	Naphthalene	9	
S9MW 17	01/18/96	Naphthalene	6	J
S9MW 19D	06/28/95	Naphthalene	3.42	
S9MW 6	01/18/96	Naphthalene	3	J
S9MW 3	01/18/96	Naphthalene	2	J
TOTAL PETROLEUM HYDROCARBONS (µg/L)				
S9MW 5	10/93	TPH	46,000	
S9MW 4	10/93	TPH	6,000	
S9MW 3	10/93	TPH	2,000	
S9MW 17	06/28/95	TPH	1,920	
S9MW 20D	06/28/95	TPH	1,700	
S9MW 1	06/28/95	TPH	1,580	
S9MW 10	06/28/95	TPH	1,410	
S9MW 19D	06/28/95	TPH	1,240	
S9MW 3	06/29/95	TPH	1,120	
S9MW 13	06/28/95	TPH	1,050	
S9MW 2	10/93	TPH	1,000	
VOLATILE ORGANIC COMPOUNDS (µg/L)				
S9MW 2	06/28/95	1,1,1-trichloroethane	13.5	
S9MW 15	12/93	1,1,1-trichloroethane	3.9	
S9MW 16	06/28/95	1,1,1-trichloroethane	2	X
S9MW 18	06/28/95	1,1,1-trichloroethane	2	X
S9MW 19D	06/28/95	1,1,1-trichloroethane	2	X

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S9MW 23	06/27/95	1,1,1-trichloroethane	2	X
S9MW 6	06/27/95	1,1,1-trichloroethane	2	X
S9MW 8	06/28/95	1,1,1-trichloroethane	2	X
S9MW 2	06/28/95	1,1,2,2-tetrachloroethane	13.5	
S9MW 16	06/28/95	1,1,2,2-tetrachloroethane	2	X
S9MW 18	06/28/95	1,1,2,2-tetrachloroethane	2	X
S9MW 19D	06/28/95	1,1,2,2-tetrachloroethane	2	X
S9MW 23	06/27/95	1,1,2,2-tetrachloroethane	2	X
S9MW 6	06/27/95	1,1,2,2-tetrachloroethane	2	X
S9MW 8	06/28/95	1,1,2,2-tetrachloroethane	2	X
S9MW 2	06/28/95	1,1,2-trichloroethane	13.5	
S9MW 16	06/28/95	1,1,2-trichloroethane	2	X
S9MW 18	06/28/95	1,1,2-trichloroethane	2	X
S9MW 19D	06/28/95	1,1,2-trichloroethane	2	X
S9MW 23	06/27/95	1,1,2-trichloroethane	2	X
S9MW 6	06/27/95	1,1,2-trichloroethane	2	X
S9MW 8	06/28/95	1,1,2-trichloroethane	2	X
S9MW 2	06/28/95	1,1-dichloroethane	13.5	
S9MW 16	06/28/95	1,1-dichloroethane	2	X
S9MW 18	06/28/95	1,1-dichloroethane	2	X
S9MW 19D	06/28/95	1,1-dichloroethane	2	X
S9MW 23	06/27/95	1,1-dichloroethane	2	X
S9MW 6	06/27/95	1,1-dichloroethane	2	X
S9MW 8	06/28/95	1,1-dichloroethane	2	X
S9MW 2	06/28/95	1,1-dichloroethene	13.5	
S9MW 16	06/28/95	1,1-dichloroethene	2	X
S9MW 18	06/28/95	1,1-dichloroethene	2	X
S9MW 19D	06/28/95	1,1-dichloroethene	2	X
S9MW 23	06/27/95	1,1-dichloroethene	2	X
S9MW 24	01/18/96	1,1-dichloroethene	2	J
S9MW 6	06/27/95	1,1-dichloroethene	2	X
S9MW 8	06/28/95	1,1-dichloroethene	2	X
S9MW 2	06/28/95	1,2-dichloroethane	13.5	
S9MW 16	06/28/95	1,2-dichloroethane	2	X
S9MW 18	06/28/95	1,2-dichloroethane	2	X
S9MW 19D	06/28/95	1,2-dichloroethane	2	X
S9MW 23	06/27/95	1,2-dichloroethane	2	X
S9MW 6	06/27/95	1,2-dichloroethane	2	X
S9MW 8	06/28/95	1,2-dichloroethane	2	X
S9MW 14	10/93	1,2-dichloroethene (total)	35	
S9MW 15	10/93	1,2-dichloroethene (total)	25	
S9MW 2	06/28/95	1,2-dichloropropane	13.5	
S9MW 16	06/28/95	1,2-dichloropropane	2	X
S9MW 18	06/28/95	1,2-dichloropropane	2	X
S9MW 19D	06/28/95	1,2-dichloropropane	2	X
S9MW 23	06/27/95	1,2-dichloropropane	2	X
S9MW 6	06/27/95	1,2-dichloropropane	2	X
S9MW 8	06/28/95	1,2-dichloropropane	2	X
S9MW 2	06/28/95	2-butanone	67.5	
S9MW 16	06/28/95	2-butanone	10	X
S9MW 18	06/28/95	2-butanone	10	X
S9MW 19D	06/28/95	2-butanone	10	X
S9MW 23	06/27/95	2-butanone	10	X
S9MW 6	06/27/95	2-butanone	10	X
S9MW 8	06/28/95	2-butanone	10	X
S9MW 2	06/28/95	2-hexanone	67.5	
S9MW 16	06/28/95	2-hexanone	10	X
S9MW 18	06/28/95	2-hexanone	10	X
S9MW 19D	06/28/95	2-hexanone	10	X
S9MW 23	06/27/95	2-hexanone	10	X
S9MW 6	06/27/95	2-hexanone	10	X
S9MW 8	06/28/95	2-hexanone	10	X
HY03	07/25/95	2-hexanone	2.32	JB

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S9MW 2	06/28/95	4-methyl-2-pentanone	67.5	
S9MW 16	06/28/95	4-methyl-2-pentanone	10	X
S9MW 18	06/28/95	4-methyl-2-pentanone	10	X
S9MW 19D	06/28/95	4-methyl-2-pentanone	10	X
S9MW 23	06/27/95	4-methyl-2-pentanone	10	X
S9MW 6	06/27/95	4-methyl-2-pentanone	10	X
S9MW 8	06/28/95	4-methyl-2-pentanone	10	X
HY09	07/27/95	Acetone	100	
S9MW 3	01/18/96	Acetone	68	
S9MW 2	06/28/95	Acetone	67.5	
S9MW 19D	01/18/96	Acetone	29	
HY08	07/28/95	Acetone	19	
HY03	07/25/95	Acetone	11.9	B
S9MW 13	06/28/95	Acetone	10.9	
HY02	07/25/95	Acetone	10.7	B
S9MW 16	06/28/95	Acetone	10	X
S9MW 18	06/28/95	Acetone	10	X
S9MW 19D	06/28/95	Acetone	10	X
S9MW 23	06/27/95	Acetone	10	X
S9MW 6	06/27/95	Acetone	10	X
S9MW 8	06/28/95	Acetone	10	X
HY01	07/25/95	Acetone	8.14	JB
HY03	07/25/95	Acetone	7.58	JB
HY04	07/25/95	Acetone	5.925	JB
HY06	07/25/95	Acetone	5.36	JB
HY05	07/25/95	Acetone	5.17	JB
HY10	07/27/95	Acetone	5	J
S9MW 5	10/93	Benzene	56	
S9MW 23	06/27/95	Benzene	55.2	X
S9MW 2	06/28/95	Benzene	13.5	
S9MW 16	06/28/95	Benzene	13.2	X
S9MW 19D	06/28/95	Benzene	11.8	X
S9MW 15	12/93	Benzene	9.3	
S9MW 24	06/27/95	Benzene	7	
S9MW 24	01/18/96	Benzene	4	
S9MW 24	02/94	Benzene	3.8	
S9MW 18	06/28/95	Benzene	2	X
S9MW 4	10/93	Benzene	2	
S9MW 6	06/27/95	Benzene	2	X
S9MW 8	06/28/95	Benzene	2	X
S9MW 14	12/93	Benzene	1.6	
S9MW 2	06/28/95	Bromodichloromethane	13.5	
S9MW 16	06/28/95	Bromodichloromethane	2	X
S9MW 18	06/28/95	Bromodichloromethane	2	X
S9MW 19D	06/28/95	Bromodichloromethane	2	X
S9MW 23	06/27/95	Bromodichloromethane	2	X
S9MW 6	06/27/95	Bromodichloromethane	2	X
S9MW 8	06/28/95	Bromodichloromethane	2	X
HY03	07/25/95	Bromodichloromethane	0.202	J
S9MW 2	06/28/95	Bromoform	13.5	
S9MW 16	06/28/95	Bromoform	2	X
S9MW 18	06/28/95	Bromoform	2	X
S9MW 19D	06/28/95	Bromoform	2	X
S9MW 23	06/27/95	Bromoform	2	X
S9MW 6	06/27/95	Bromoform	2	X
S9MW 8	06/28/95	Bromoform	2	X
S9MW 2	06/28/95	Bromomethane	13.5	
S9MW 16	06/28/95	Bromomethane	2	X
S9MW 18	06/28/95	Bromomethane	2	X
S9MW 19D	06/28/95	Bromomethane	2	X
S9MW 23	06/27/95	Bromomethane	2	X
S9MW 6	06/27/95	Bromomethane	2	X
S9MW 8	06/28/95	Bromomethane	2	X

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (μg/L) (cont.)				
S9MW 2	06/28/95	Carbon disulfide	67.5	
S9MW 16	06/28/95	Carbon disulfide	10	X
S9MW 18	06/28/95	Carbon disulfide	10	X
S9MW 19D	06/28/95	Carbon disulfide	10	X
S9MW 23	06/27/95	Carbon disulfide	10	X
S9MW 6	06/27/95	Carbon disulfide	10	X
S9MW 8	06/28/95	Carbon disulfide	10	X
S9MW 21	01/18/96	Carbon disulfide	0.14	J
S9MW 19D	01/18/96	Carbon disulfide	0.11	J
S9MW 2	06/28/95	Carbon tetrachloride	13.5	
S9MW 16	06/28/95	Carbon tetrachloride	2	X
S9MW 18	06/28/95	Carbon tetrachloride	2	X
S9MW 19D	06/28/95	Carbon tetrachloride	2	X
S9MW 23	06/27/95	Carbon tetrachloride	2	X
S9MW 6	06/27/95	Carbon tetrachloride	2	X
S9MW 8	06/28/95	Carbon tetrachloride	2	X
S9MW 2	06/28/95	Chlorobenzene	13.5	
S9MW 16	06/28/95	Chlorobenzene	2	X
S9MW 18	06/28/95	Chlorobenzene	2	X
S9MW 19D	06/28/95	Chlorobenzene	2	X
S9MW 23	06/27/95	Chlorobenzene	2	X
S9MW 6	06/27/95	Chlorobenzene	2	X
S9MW 8	06/28/95	Chlorobenzene	2	X
S9MW 2	06/28/95	Chloroethane	13.5	
S9MW 16	06/28/95	Chloroethane	2	X
S9MW 18	06/28/95	Chloroethane	2	X
S9MW 19D	06/28/95	Chloroethane	2	X
S9MW 23	06/27/95	Chloroethane	2	X
S9MW 6	06/27/95	Chloroethane	2	X
S9MW 8	06/28/95	Chloroethane	2	X
S9MW 2	06/28/95	Chloroform	13.5	

Location	Date	Parameter	Result	Qual.(1)
S9MW 16	06/28/95	Chloroform	2	X
S9MW 18	06/28/95	Chloroform	2	X
S9MW 19D	06/28/95	Chloroform	2	X
S9MW 23	06/27/95	Chloroform	2	X
S9MW 6	06/27/95	Chloroform	2	X
S9MW 8	06/28/95	Chloroform	2	X
HY04	07/25/95	Chloroform	1.07	
S9MW 2	06/28/95	Chloromethane	13.5	
S9MW 16	06/28/95	Chloromethane	2	X
S9MW 18	06/28/95	Chloromethane	2	X
S9MW 19D	06/28/95	Chloromethane	2	X
S9MW 23	06/27/95	Chloromethane	2	X
S9MW 6	06/27/95	Chloromethane	2	X
S9MW 8	06/28/95	Chloromethane	2	X
S9MW 24	06/27/95	Cis-1,2-dichloroethene	1,560	D
S9MW 15	12/93	Cis-1,2-dichloroethene	1,300	E
S9MW 15	12/93	Cis-1,2-dichloroethene	980	
S9MW 14	12/93	Cis-1,2-dichloroethene	950	E
S9MW 24	02/94	Cis-1,2-dichloroethene	770	
S9MW 24	06/27/95	Cis-1,2-dichloroethene	752	E
S9MW 14	12/93	Cis-1,2-dichloroethene	480	
S9MW 24	02/94	Cis-1,2-dichloroethene	410	E
S9MW 15	06/27/95	Cis-1,2-dichloroethene	196	D
S9MW 15	06/27/95	Cis-1,2-dichloroethene	159	E
S9MW 15	02/94	Cis-1,2-dichloroethene	120	
S9MW 14	02/94	Cis-1,2-dichloroethene	74	
S9MW 21	02/94	Cis-1,2-dichloroethene	73	
HY01	07/25/95	Cis-1,2-dichloroethene	56.7	
S9MW 21	06/27/95	Cis-1,2-dichloroethene	51.3	
S9MW 14	06/27/95	Cis-1,2-dichloroethene	18.4	
S9MW 22	06/27/95	Cis-1,2-dichloroethene	15	
S9MW 2	06/28/95	Cis-1,2-dichloroethene	13.5	

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S9MW 23	06/27/95	Cis-1,2-dichloroethene	13.2	X
S9MW 22	06/27/95	Cis-1,2-dichloroethene	13	
S9MW 22	02/94	Cis-1,2-dichloroethene	4.2	
S9MW 16	06/28/95	Cis-1,2-dichloroethene	2	X
S9MW 18	06/28/95	Cis-1,2-dichloroethene	2	X
S9MW 19D	06/28/95	Cis-1,2-dichloroethene	2	X
S9MW 6	06/27/95	Cis-1,2-dichloroethene	2	X
S9MW 8	06/28/95	Cis-1,2-dichloroethene	2	X
S9MW 2	06/28/95	Cis-1,3-dichloropropene	13.5	
S9MW 16	06/28/95	Cis-1,3-dichloropropene	2	X
S9MW 18	06/28/95	Cis-1,3-dichloropropene	2	X
S9MW 19D	06/28/95	Cis-1,3-dichloropropene	2	X
S9MW 23	06/27/95	Cis-1,3-dichloropropene	2	X
S9MW 6	06/27/95	Cis-1,3-dichloropropene	2	X
S9MW 8	06/28/95	Cis-1,3-dichloropropene	2	X
S9MW 5	10/93	Ethylbenzene	70	
S9MW 4	10/93	Ethylbenzene	54	
S9MW 2	10/93	Ethylbenzene	33	
S9MW 2	06/28/95	Ethylbenzene	14.5125	
S9MW 3	10/93	Ethylbenzene	4	
S9MW 16	06/28/95	Ethylbenzene	2	X
S9MW 18	06/28/95	Ethylbenzene	2	X
S9MW 19D	06/28/95	Ethylbenzene	2	X
S9MW 23	06/27/95	Ethylbenzene	2	X
S9MW 6	06/27/95	Ethylbenzene	2	X
S9MW 8	06/28/95	Ethylbenzene	2	X
HY09	07/27/95	Isopropyl alcohol	23	NJ
S9MW 23	06/27/95	Methylene chloride	92.2	JDB
S9MW 6	06/27/95	Methylene chloride	77.5	JDB
S9MW 18	06/28/95	Methylene chloride	21.2	JDB
S9MW 16	06/28/95	Methylene chloride	20.7	JDB

Location	Date	Parameter	Result	Qual.(1)
S9MW 8	06/28/95	Methylene chloride	20	JDB
S9MW 19D	06/28/95	Methylene chloride	19.7	JDB
S9MW 2	06/28/95	Methylene chloride	12.7	JDB
S9MW 16	06/28/95	Methylene chloride	5	X
S9MW 18	06/28/95	Methylene chloride	5	X
S9MW 19D	06/28/95	Methylene chloride	5	X
S9MW 23	06/27/95	Methylene chloride	5	X
S9MW 6	06/27/95	Methylene chloride	5	X
S9MW 8	06/28/95	Methylene chloride	5	X
S9MW 9	06/28/95	Methylene chloride	3.87	JB
S9MW 17	06/28/95	Methylene chloride	3.76	JB
S9MW 13	06/28/95	Methylene chloride	3.64	JB
S9MW 10	06/28/95	Methylene chloride	3.54	JB
S9MW 11	06/29/95	Methylene chloride	3.06	JB
S9MW 20D	06/28/95	Methylene chloride	2.9	JB
S9MW 12	06/29/95	Methylene chloride	2.43	JB
S9MW 3	06/29/95	Methylene chloride	2.19	JB
S9MW 1	06/28/95	Methylene chloride	0.695	JB
S9MW 7	06/27/95	Methylene chloride	0.602	JB
HY03	07/25/95	Methylene chloride	0.508	JB
HY03	07/25/95	Methylene chloride	0.501	JB
HY02	07/25/95	Methylene chloride	0.494	JB
HY06	07/25/95	Methylene chloride	0.45	JB
HY01	07/25/95	Methylene chloride	0.418	JB
S9MW 2	06/28/95	Styrene	67.5	
S9MW 16	06/28/95	Styrene	10	X
S9MW 18	06/28/95	Styrene	10	X
S9MW 19D	06/28/95	Styrene	10	X
S9MW 23	06/27/95	Styrene	10	X
S9MW 6	06/27/95	Styrene	10	X
S9MW 8	06/28/95	Styrene	10	X
S9MW 2	06/28/95	Tetrachloroethene	13.5	

TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST
PAGE 7 OF 8

Location	Date	Parameter	Result	Qual.(1)
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S9MW 16	06/28/95	Tetrachloroethene	2	X
S9MW 18	06/28/95	Tetrachloroethene	2	X
S9MW 19D	06/28/95	Tetrachloroethene	2	X
S9MW 23	06/27/95	Tetrachloroethene	2	X
S9MW 6	06/27/95	Tetrachloroethene	2	X
S9MW 8	06/28/95	Tetrachloroethene	2	X
HY06	07/25/95	Tetrachloroethene	0.0681	J
S9MW 2	06/28/95	Toluene	13.5	
S9MW 16	06/28/95	Toluene	2	X
S9MW 18	06/28/95	Toluene	2	X
S9MW 19D	06/28/95	Toluene	2	X
S9MW 6	06/27/95	Toluene	2	X
S9MW 8	06/28/95	Toluene	2	X
S9MW 23	06/27/95	Toluene	0.618	J
HY03	07/25/95	Toluene	0.308	J
HY02	07/25/95	Toluene	0.248	J
HY04	07/25/95	Toluene	0.194	JB
HY03	07/25/95	Toluene	0.171	JB
HY06	07/25/95	Toluene	0.061	JB
S9MW 24	01/18/96	Trans-1,2-dichloroethene	3,060	
S9MW 15	12/93	Trans-1,2-dichloroethene	2,800	
S9MW 24	06/27/95	Trans-1,2-dichloroethene	2,420	D
S9MW 24	06/27/95	Trans-1,2-dichloroethene	1,920	E
S9MW 15	12/93	Trans-1,2-dichloroethene	1,700	E
S9MW 14	12/93	Trans-1,2-dichloroethene	1,400	
S9MW 14	12/93	Trans-1,2-dichloroethene	1,300	E
S9MW 24	02/94	Trans-1,2-dichloroethene	890	
S9MW 15	06/27/95	Trans-1,2-dichloroethene	495	D
S9MW 15	06/27/95	Trans-1,2-dichloroethene	469	E
S9MW 24	02/94	Trans-1,2-dichloroethene	390	E
S9MW 15	02/94	Trans-1,2-dichloroethene	280	
S9MW 14	02/94	Trans-1,2-dichloroethene	180	
S9MW 14	06/27/95	Trans-1,2-dichloroethene	56.2	
S9MW 15	01/18/96	Trans-1,2-dichloroethene	53	
S9MW 22	06/27/95	Trans-1,2-dichloroethene	23.5	
S9MW 22	06/27/95	Trans-1,2-dichloroethene	19.2	
S9MW 2	06/28/95	Trans-1,2-dichloroethene	13.5	
S9MW 21	06/27/95	Trans-1,2-dichloroethene	6.82	
S9MW 21	02/94	Trans-1,2-dichloroethene	6.6	
S9MW 19D	01/18/96	Trans-1,2-dichloroethene	5	
S9MW 21	01/18/96	Trans-1,2-dichloroethene	5	
HY01	07/25/95	Trans-1,2-dichloroethene	4.58	
S9MW 16	06/28/95	Trans-1,2-dichloroethene	2	X
S9MW 18	06/28/95	Trans-1,2-dichloroethene	2	X
S9MW 19D	06/28/95	Trans-1,2-dichloroethene	2	X
S9MW 23	06/27/95	Trans-1,2-dichloroethene	2	X
S9MW 6	06/27/95	Trans-1,2-dichloroethene	2	X
S9MW 8	06/28/95	Trans-1,2-dichloroethene	2	X
S9MW 2	06/28/95	Trans-1,3-dichloropropene	13.5	
S9MW 16	06/28/95	Trans-1,3-dichloropropene	2	X
S9MW 18	06/28/95	Trans-1,3-dichloropropene	2	X
S9MW 19D	06/28/95	Trans-1,3-dichloropropene	2	X
S9MW 23	06/27/95	Trans-1,3-dichloropropene	2	X
S9MW 6	06/27/95	Trans-1,3-dichloropropene	2	X
S9MW 8	06/28/95	Trans-1,3-dichloropropene	2	X
S9MW 15	12/93	Trichloroethene	44	
S9MW 15	12/93	Trichloroethene	41	
S9MW 2	06/28/95	Trichloroethene	13.5	
S9MW 22	02/94	Trichloroethene	4.6	
S9MW 22	06/27/95	Trichloroethene	2.41	
S9MW 24	02/94	Trichloroethene	2.4	
S9MW 22	06/27/95	Trichloroethene	2.34	
S9MW 16	06/28/95	Trichloroethene	2	X

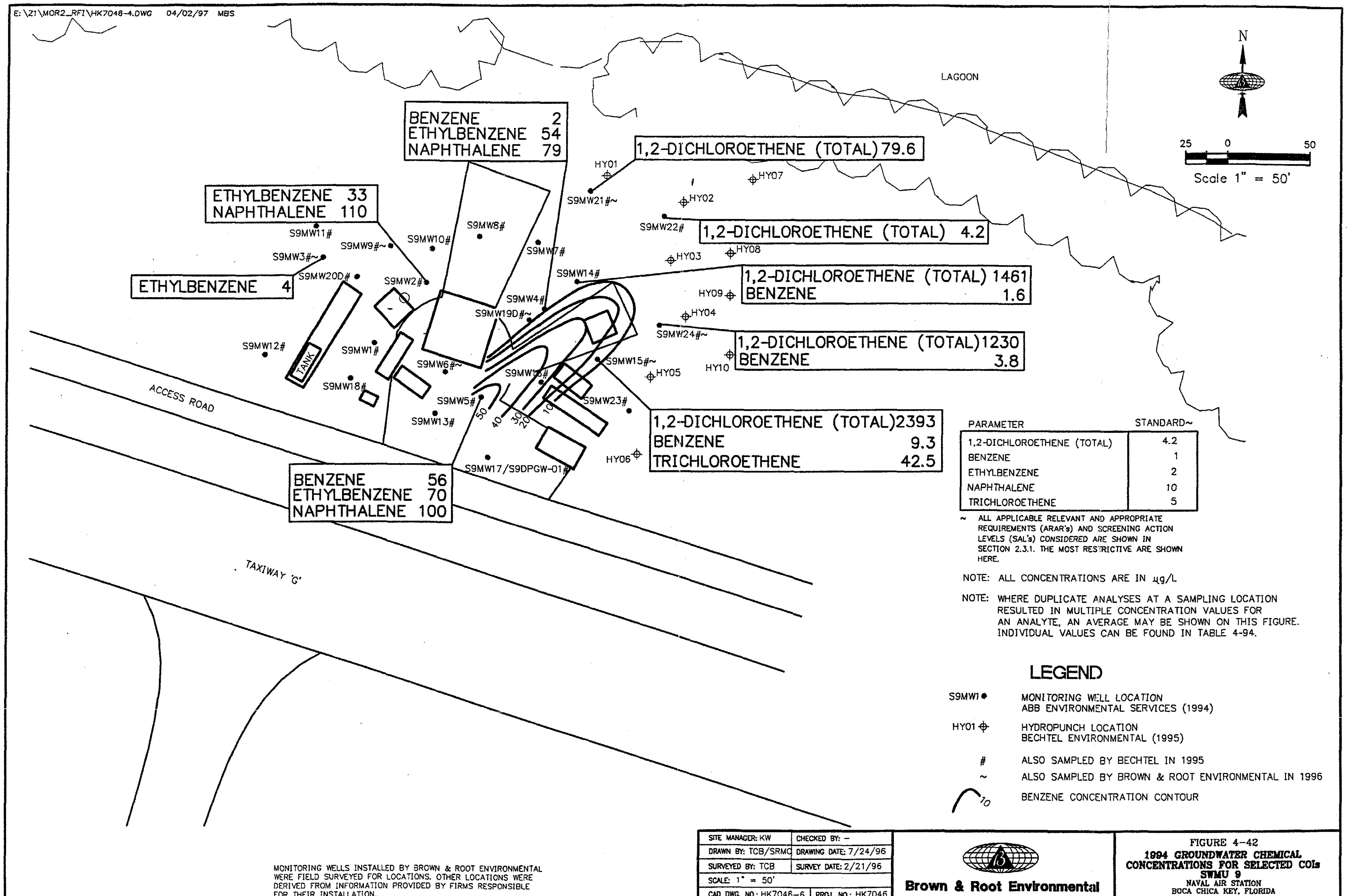
TABLE 4-94

CONTAMINANTS DETECTED IN GROUNDWATER AT SWMU 9
NAS KEY WEST

Location	Date	Parameter	Result	Qual.[1]
VOLATILE ORGANIC COMPOUNDS (µg/L) (cont.)				
S9MW 18	06/28/95	Trichloroethene	2	X
S9MW 19D	06/28/95	Trichloroethene	2	X
S9MW 23	06/27/95	Trichloroethene	2	X
S9MW 6	06/27/95	Trichloroethene	2	X
S9MW 8	06/28/95	Trichloroethene	2	X
S9MW 15	02/94	Trichloroethene	1.8	
S9MW 14	12/93	Trichloroethene	1.5	
S9MW 3	10/93	Trichlorofluoromethane	3	
S9MW 5	10/93	Trichlorofluoromethane	3	
S9MW 2	06/28/95	Vinyl acetate	67.5	
S9MW 16	06/28/95	Vinyl acetate	10	X
S9MW 18	06/28/95	Vinyl acetate	10	X
S9MW 19D	06/28/95	Vinyl acetate	10	X
S9MW 23	06/27/95	Vinyl acetate	10	X
S9MW 6	06/27/95	Vinyl acetate	10	X
S9MW 8	06/28/95	Vinyl acetate	10	X
S9MW 24	01/18/96	Vinyl acetate	5	
S9MW 9	01/18/96	Vinyl acetate	3	J
S9MW 2	06/28/95	Vinyl chloride	13.5	
S9MW 16	06/28/95	Vinyl chloride	2	X
S9MW 18	06/28/95	Vinyl chloride	2	X
S9MW 19D	06/28/95	Vinyl chloride	2	X
S9MW 23	06/27/95	Vinyl chloride	2	X
S9MW 6	06/27/95	Vinyl chloride	2	X
S9MW 8	06/28/95	Vinyl chloride	2	X
S9MW 2	06/28/95	Xylenes (total)	131.6025	
S9MW 16	06/28/95	Xylenes (total)	20	X
S9MW 18	06/28/95	Xylenes (total)	20	X
S9MW 19D	06/28/95	Xylenes (total)	20	X
S9MW 23	06/27/95	Xylenes (total)	20	X
S9MW 6	06/27/95	Xylenes (total)	20	X
S9MW 8	06/28/95	Xylenes (total)	20	X
S9MW 3	10/93	Xylenes (total)	4	
S9MW 5	10/93	Xylenes (total)	3	
S9MW 4	10/93	Xylenes (total)	2	

Shading indicates a concentration in excess of the most restrictive ARAR or SAL criteria (see Table 2-6).

1 Refer to the lab data sheets from the appropriate investigation for an explanation of the qualifier codes. Appendix L of this report contains the data sheets for samples analyzed in conjunction with the Supplemental RFI/RI. Data sheets from previous investigations can be found as follows: Appendix C of the 1987 Geraghty and Miller Verification Study, Appendix G of IT's 1991 RI Report, Appendix I of the 1994 RFI/RI Report, and Appendices 1, 2, and 3 of the 1995 BEI Delineation Study.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LAGOON
N
25 0 50
Scale 1" = 50'
BENZENE 2
ETHYLBENZENE 54
NAPHTHALENE 79
ETHYLBENZENE 33
NAPHTHALENE 110
ETHYLBENZENE 4
1,2-DICHLOROETHENE (TOTAL) 79.6
1,2-DICHLOROETHENE (TOTAL) 4.2
1,2-DICHLOROETHENE (TOTAL) 1461
BENZENE 1.6
1,2-DICHLOROETHENE (TOTAL) 1230
BENZENE 3.8
1,2-DICHLOROETHENE (TOTAL) 2393
BENZENE 9.3
TRICHLOROETHENE 42.5
BENZENE 56
ETHYLBENZENE 70
NAPHTHALENE 100
HY01
HY02
HY03
HY04
HY05
HY06
HY07
HY08
HY09
HY10
S9MW1#
S9MW2#
S9MW3#~
S9MW4#
S9MW5#
S9MW6#~
S9MW7#
S9MW8#
S9MW9#~
S9MW10#
S9MW11#
S9MW12#
S9MW13#
S9MW14#
S9MW15#~
S9MW16#
S9MW17/S9DPGW-01#
S9MW18#
S9MW19D#~
S9MW20D#
S9MW21#~
S9MW22#
S9MW23#
S9MW24#~
TANK
ACCESS ROAD
TAXIWAY 'G'
50
40
30
20
10
PARAMETER
STANDARD~
1,2-DICHLOROETHENE (TOTAL) 4.2
BENZENE 1
ETHYLBENZENE 2
NAPHTHALENE 10
TRICHLOROETHENE 5
~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.
NOTE: ALL CONCENTRATIONS ARE IN μg/L
NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-94.
LEGEND
S9MW1 MONITORING WELL LOCATION ABB ENVIRONMENTAL SERVICES (1994)
HY01 HYDROPUNCH LOCATION BECHTEL ENVIRONMENTAL (1995)
ALSO SAMPLED BY BECHTEL IN 1995
~ ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL IN 1996
10 BENZENE CONCENTRATION CONTOUR
MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.
SITE MANAGER: KW
CHECKED BY: -
DRAWN BY: TCB/SRMC
DRAWING DATE: 7/24/96
SURVEYED BY: TCB
SURVEY DATE: 2/21/96
SCALE: 1" = 50'
CAD DWG. NO.: HK7046-6
PROJ. NO.: HK7046
Brown & Root Environmental
FIGURE 4-42
1994 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

00905B217

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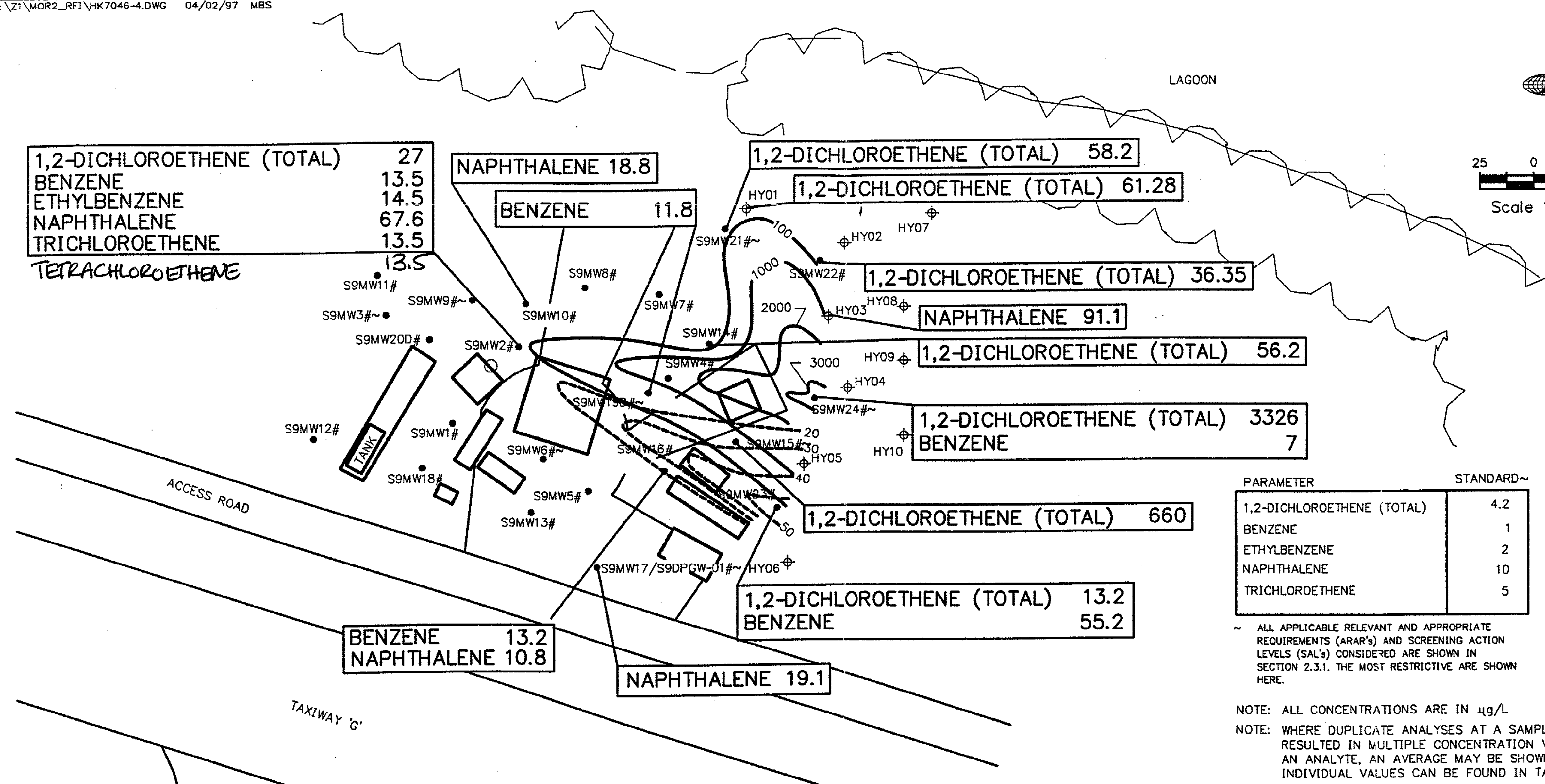

PARAMETER	STANDARD~
1,2-DICHLOROETHENE (TOTAL)	4.2
BENZENE	1
ETHYLBENZENE	2
NAPHTHALENE	10
TRICHLOROETHENE	5

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN µg/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-94.

LEGEND

S9MW1 ● MONITORING WELL LOCATION ABB ENVIRONMENTAL SERVICES (1994)

HY01 ⊕ HYDROPUNCH LOCATION BECHTEL ENVIRONMENTAL (1995)

\# ALSO SAMPLED BY BECHTEL IN 1995

~ ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL IN 1996

100 1,2-DICHLOROETHENE (TOTAL) CONCENTRATION CONTOUR

10 BENZENE CONCENTRATION CONTOUR

NOTE: BENZENE ALSO APPEARS TO HAVE BEEN FOUND IN MW-8, MW-6 AND MW-18 AT A CONCENTRATION OF 2 µg/L. HOWEVER, THIS IS NOT SHOWN HERE, BECAUSE THERE IS A REASON TO SUSPECT THAT THESE SAMPLES MAY ACTUALLY BE NON-DETECT VALUES FOR BENZENE.

NOTE: THIS FIGURE INDICATES THE CHEMICALS OF INTEREST AT THIS SITE. OTHER CHEMICALS IN EXCESS OF ARAR's/SAL's ARE THE FOLLOWING:

1,1,2,2-TETRACHLOROETHANE	CHLOROBENZENE
1,1,2-TRICHLOROETHENE	CHLOROFORM
1,1-DICHLOROETHENE	METHYLENE CHLORIDE
1,2-DICHLOROETHANE	TETRACHLOROETHENE
1,2-DICHLOROPROPANE	VINYL CHLORIDE
BROMODICHLOROMETHANE	
CARBON TETRACHLORIDE	

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: –
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-43
1995 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

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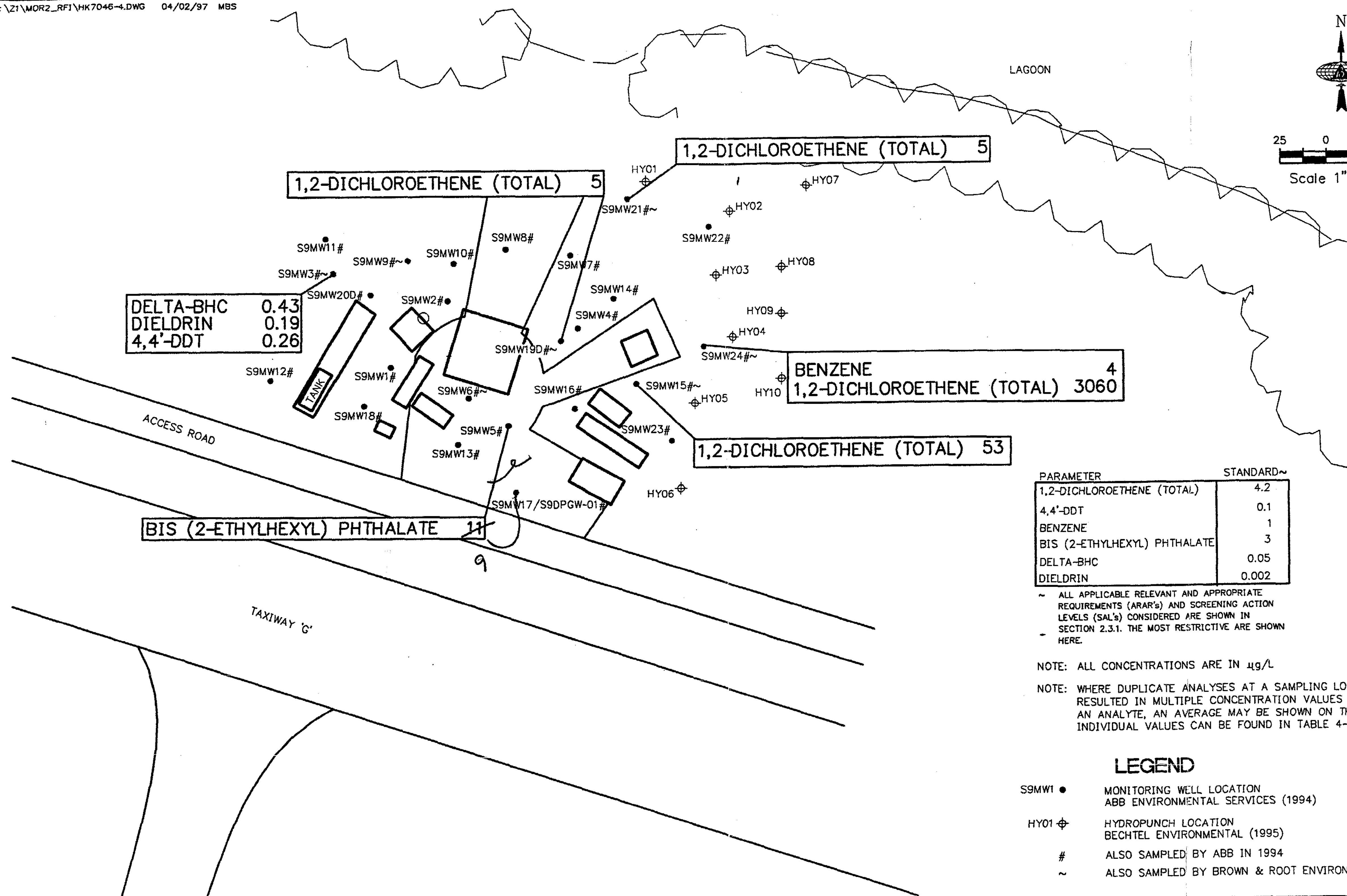


PARAMETER	STANDARD~
1,2-DICHLOROETHENE (TOTAL)	4.2
4,4'-DDT	0.1
BENZENE	1
BIS (2-ETHYLHEXYL) PHTHALATE	3
DELTA-BHC	0.05
DIELDRIN	0.002

~ ALL APPLICABLE RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR's) AND SCREENING ACTION LEVELS (SAL's) CONSIDERED ARE SHOWN IN SECTION 2.3.1. THE MOST RESTRICTIVE ARE SHOWN HERE.

NOTE: ALL CONCENTRATIONS ARE IN µg/L

NOTE: WHERE DUPLICATE ANALYSES AT A SAMPLING LOCATION RESULTED IN MULTIPLE CONCENTRATION VALUES FOR AN ANALYTE, AN AVERAGE MAY BE SHOWN ON THIS FIGURE. INDIVIDUAL VALUES CAN BE FOUND IN TABLE 4-94.

LEGEND

S9MW1 ● MONITORING WELL LOCATION ABB ENVIRONMENTAL SERVICES (1994)

HY01 ⊕ HYDROPUNCH LOCATION BECHTEL ENVIRONMENTAL (1995)

\# ALSO SAMPLED BY ABB IN 1994

~ ALSO SAMPLED BY BROWN & ROOT ENVIRONMENTAL IN 1996

MONITORING WELLS INSTALLED BY BROWN & ROOT ENVIRONMENTAL WERE FIELD SURVEYED FOR LOCATIONS. OTHER LOCATIONS WERE DERIVED FROM INFORMATION PROVIDED BY FIRMS RESPONSIBLE FOR THEIR INSTALLATION.

SITE MANAGER: KW	CHECKED BY: -
DRAWN BY: TCB/SRMC	DRAWING DATE: 7/24/96
SURVEYED BY: TCB	SURVEY DATE: 2/21/96
SCALE: 1" = 50'	
CAD DWG. NO.: HK7046-6	PROJ. NO.: HK7046

Brown & Root Environmental

FIGURE 4-44
1996 GROUNDWATER CHEMICAL CONCENTRATIONS FOR SELECTED COIs
SWMU 9
NAVAL AIR STATION
BOCA CHICA KEY, FLORIDA

detected during the contamination assessment was also found in S9MW-5, with lower concentrations detected in wells to the north and northwest. Ethylbenzene was detected during the groundwater assessment investigation at a concentration of 14.5 μg/L in S9MW-2, which is down 56 percent from the previous observation at that location. Ethylbenzene was not detected in any of the groundwater samples during the Supplemental RFI/RI. 1,2-DCE (total) was identified during the contamination assessment at several wells surrounding the former testing area and the storage shed. 1,2-DCE (total) was detected at higher levels during the groundwater evaluation. The maximum of 3,326 μg/L occurred in S9MW-24, and a two-fingered plume appeared to extend to the west and northwest (Figure 4-43). Values of 1,2-DCE (total) were detected at lower levels during the Supplemental RFI/RI, with the maximum value again found in S9MW-24 (3,060 μg/l). TCE concentrations exceeded the 5 μg/L MCL in a single well to the east of the former testing area during the contamination assessment. A single well (S9MW-2) also exceeded the standard during the groundwater evaluation. This well is located to the west of the current testing apron and exhibited a concentration of 13.5 μg/L of TCE. TCE was not detected during the Supplemental RFI/RI.

A number of additional VOCs were detected in the groundwater during the groundwater evaluation above their respective ARAR/SAL criteria. These compounds include 1,1,2-TCA, 1,1,2,2-tetrachloroethane, 1,2-DCA, 1,1-DCE, 1,2-dichloropropane (DCP), bromodichloromethane, carbon tetrachloride, chlorobenzene, chloroform, methylene chloride, PCE, and vinyl chloride. Methylene chloride was found in a number of wells under and surrounding the concrete testing pad. The other compounds were detected in a number of wells during the BEI groundwater evaluation, but the data appear to be questionable. Many of the detections in the data are likely non-detect values with the quantitation limit used as the result and an unspecified "X" qualifier flagging the data point. The highest values for these data points were detected at S9MW-12. None of these data points were obtained during the Supplemental RFI/RI, so validation of this data was not performed.

4.4.5.4.2 Semivolatile Organic Compounds

In the course of all three studies, only two SVOCs were determined to exceed ARARs/SALs in the groundwater beneath the Jet Engine Test Cell. Naphthalene was detected at decreasing concentrations in the previous investigations and was not detected during the Supplemental RFI/RI. Bis(2-ethylhexyl)phthalate was detected during the Supplemental RFI/RI in a single well at the southern end of the concrete testing pad near the access road. Its concentration was 9 μg/L, as compared to a 3-μg/L proposed RCRA Action Level. Other SVOCs that were detected but did not exceed ARAR/SAL criteria include chlorodibromomethane, 1,4-DCB, 1-methyl naphthalene, and 2-methyl naphthalene.

4.4.5.4.3 Pesticides

Only Supplemental RFI/RI samples were analyzed for pesticides. S9MW-3, to the east of the concrete testing pad and the four aboveground storage tanks, was the only well with pesticide levels above ARARs/SALs. The compounds 4,4'-DDT (0.26 µg/L), dieldrin (0.19 µg/L), and delta-BHC (0.43 µg/L) were detected above their respective ARARs/SALs.

4.4.5.4.4 PCBs

No PCBs were detected in the groundwater at SMWU-9.

4.4.5.4.5 Metals and Inorganics

Only Supplemental RFI/RI samples were analyzed for metals. None were detected in excess of the most conservative ARAR or SAL, although arsenic, barium, cyanide, lead, manganese, selenium, silver, and vanadium were detected at low levels in various wells.

4.4.5.5 Summary of Contaminant Release

Fuels, oils, and solvents stored at the Jet Engine Test Cell are potential sources of contamination. Several fuel spills have been documented, and VOC and SVOC fuel constituents were detected as groundwater contaminants. Chlorinated VOCs were also frequently detected groundwater contaminants; however, the three solvents reportedly used for cleaning and degreasing at the site did not contain chlorinated constituents. Low levels of these same VOC and SVOC contaminants were found in soil, but metals and inorganics are the primary soil contaminants. Surface-water and sediment contaminants at the shoreline on the northern edge of the site were also predominantly metals and inorganics.

In a given year, it was possible to determine the extent of groundwater contaminant plumes based on sampling results; however, plume movement over time is uncertain due to groundwater gradients that are extremely flat, tidally influenced, and probably radial. In the contamination assessment, groundwater contaminant plumes of benzene and 1,2-DCE (total) were identified in the eastern part of the site. The groundwater evaluation confirmed the presence of both plumes. The benzene contamination was of the same magnitude seen in the previous year, but the plume appeared to have changed directions from northeast to northwest. The maximum concentration in 1995 was found to the east of the well which exhibited the 1994 maximum. This may be indicative of eastward contaminant migration. In the groundwater evaluation, the extent of DCE contamination appeared to have increased, spreading in a two fingered plume to the west and northwest. The maximum detected concentration also increased, and moved from S9MW-15 to S9MW-24, which indicates an easterly direction for contaminant migration. In 1996, benzene was detected at a level (4 µg/L) exceeding ARAR/SAL criteria in a single well. Concentrations of 1,2-DCE decreased overall; however, the maximum concentration detected during the Supplemental RFI/RI was 3,060 µg/L. Ethylbenzene and naphthalene were found to exceed ARAR/SAL criteria in groundwater during the contamination assessment in the eastern part of SWMU 9 where documented petroleum spills occurred. 1995 sampling identified free product in two of these wells (S9MW-4 and S9MW-5). Methylene chloride was detected in a number of wells under and surrounding the concrete pad. Several other VOCs and SVOCs, usually chlorinated, were also detected in isolated instances. In addition to benzene and 1,2-DCE, the Supplemental RFI/RI detected several pesticides in a single eastern well. Bis(2-ethylhexyl)phthalate exceeded its respective ARAR/SAL levels in a single well.

Soil sampling detected low levels of 1,2-DCE in the area of the groundwater plume. Methylene chloride was the only VOC or SVOC to exceed an available ARAR or SAL in either surface or subsurface soil. In one subsurface sample, it was detected slightly above the 0.366-mg/kg EPA Region III BTV. It was detected in a second subsurface sample but at a level less than the SAL. Metals were the most widespread soil contaminants. Aluminum (maximum of 4,790 mg/kg), chromium (maximum of 13.1 mg/kg) and nickel (maximum of 6.6 mg/kg) were detected in all the surface soil samples, but there did not appear to be any trend because higher concentrations were interspersed with lower ones. Chromium was also found in all subsurface samples, although concentrations were lower than those detected in the surface samples. Cyanide was significant in both surface and subsurface samples, although its maximum concentration (4.4 mg/kg) was found in a subsurface sample.

Acetone was the only VOC or SVOC detected in either surface water or sediment. It was detected in two sediment samples from the northeastern part of the shoreline at SWMU 9. Arsenic was also detected in two sediment samples, with the highest level (17.8 mg/kg) directly north of the testing area. Both mercury and cyanide were detected once in surface water and sediment, but the detections in the two media were not at the same locations. Thallium was found in all surface-water samples but at levels less than twice the 6.3 µg/l ARAR in each case.

4.4.6 Contaminant Fate and Transport

The behavior of contaminants in the environment at SWMU 9 is described in this section. Various chemicals detected and their transport potential in the environment are discussed in Section 4.1.6.1. Persistence of detected chemicals in the environment is discussed in Section 4.1.6.2. Section 4.1.6.3

discusses contaminant trends. Chemical and physical properties of COPCs detected at SWMU 9 are presented in Appendix G.

4.4.6.1 Detected Chemicals and Transport Potential

Assessment of chemical migration patterns based on all available SWMU 9 sampling data requires a special consideration of VOC results for eight groundwater samples (for a total of 296 analytical data points) from the groundwater evaluation study performed in 1995. These samples were laboratory-coded without an accompanying definition of whether values represent detection limits or positive results. In each sample, several chemical results are obviously positive hits because values are higher and different than the uniform values listed for all other substances. The majority of chemical results in the latter group apparently represent detection limit values for substances that were actually not detected. However, significant data validation efforts and expenses would be required to ascertain any hidden positive values that coincidentally might be of the same magnitude as the presumed detection limits. The baseline risk assessment has accepted these uncertain results as positive detections because risk-based decisions cannot reach a false-negative conclusion if a conservative approach (i.e., assuming the data to contain all positive results) is used. However, a more realistic approach has been applied to this fate and transport subsection because probable VOC groundwater migration patterns can only be distinguished by careful consideration of known positive results in the data set.

Analytical results for the media sampled at SWMU 9 indicate that chlorinated ethenes, aromatic volatiles, PAHs (naphthalene and derivatives), and possibly low levels of pesticides and TCFM are present in groundwater. Aromatic volatiles, two PAHs, chlorinated ethenes, acetone, and pesticides were detected in surface and subsurface soils. Acetone was detected in sediment samples. Pesticides and toluene were detected in surface water samples. Inorganics were detected in groundwater, soils, sediment, and surface-water samples, in some cases above background levels.

1,2-DCE was detected in some groundwater samples at high levels that could result in additional groundwater migration. The occurrence of this compound and the lighter PAHs and aromatic VOCs detected at lower levels in groundwater is likely to be attributable to vertical contaminant migration through soil from areas where leaks or spills might have occurred at SWMU 9. The solubility and volatility of the detected VOCs make them characteristically mobile in the environment.

Pesticides (dieldrin, a BHC, and endrin) were each detected in one groundwater sample at trace levels. The mobility of pesticides is considered compound-specific. In relation to other compounds, pesticide mobility is moderate to low. Naphthalene and related PAHs typically exhibit moderate but lower solubilities than VOCs. PAHs and aromatic volatiles might be present in groundwater in association with spills from jet fuels or hydrocarbon oils used on site.

The frequency of detection of pesticides was low, with only one detection each of three compounds in subsurface soil and four compounds in surface soil. Because pesticide detections were isolated and in the low range, these compounds do not have a significant potential for contaminant migration at SWMU 9.

4.4.6.2 Persistence

For the classes of detected chemicals, environmental persistence varies considerably. Transformation of a chemical to degradation byproducts can be the result of numerous processes including biotransformation and uptake, photolysis, acid- or base-catalyzed reaction, or hydrolysis. The product chemicals can be significantly different from a toxicological or a physical transport perspective. If the transformational process is known or suspected, product chemicals can be predicted and the extent of transformation can be determined from chemical reaction rate data. Other transformational processes can be identified empirically from analytical data.

Although most chemicals are resistant to chemical change because of their stability or lack of reaction sites, many of the more mobile species are subjected to at least limited transformation. Because of more frequent contact with reactive dissolved species and catalysts when compared to unsaturated conditions, the contaminants found in saturated media (groundwater and saturated zone soils) are most likely to be transformed in the environment. Higher molecular weight contaminants tend to be less mobile and less prone to chemical transformation.

PAHs exhibit very limited biodegradation rates in soil, with the heavier PAH compounds considered more persistent. Naphthalene and related compounds are considered among the more readily biodegradable PAHs (Clement Associates, 1985).

1,2-DCE, which is a byproduct of the degradation of TCE and PCE, can further degrade to lesser-chlorinated species. In addition, the low persistence of this compound in soil is influenced by solubility and high volatility.

Inorganic compounds have a strong tendency to adsorb onto soil and sediment particles, a factor that greatly reduces their mobility. Many metals are water-insoluble; however, some soluble species of metals have increased mobility.

4.4.6.3 Observed Chemical Contaminant Trends

Relatively high levels of 1,2-DCE isomers (in the low thousands of ppb) and low levels of TCE and 1,1-DCE were detected in three monitoring wells surrounding the storage shed at the eastern end of the jet engine testing area at SWMU 9. Low ppb levels of 1,2-DCE were detected in several other onsite monitoring wells, which indicates that limited lateral migration occurred. The location of maximum 1,2-DCE concentration was further east in 1995 and 1996 than in 1993, which is consistent with the assumed groundwater flow. 1,2-DCE can be associated with degradation of tetrachloroethene and trichloroethene in groundwater (Cline and Vista, 1983). Overall, 1,2-DCE levels north of the site in S9MW-21 declined over 3 years. Low levels of aromatic volatiles and light PAHs were also detected, most notably in two wells at the north and south edges of the circular concrete pad and in one well just east of the center of the site. Naphthalene levels in wells near the center of the site (S9MW-5) and to the northeast (S9MW-19~~A~~D) declined in concentration, although an insufficient number of well locations were sampled to determine if source areas are being depleted. Two deep monitoring wells in the same vicinity did not indicate significant vertical migration of chlorinated or aromatic VOCs.

Soil samples revealed only low levels of aromatic VOCs and 1,2-DCE, which indicates that the primary sources of groundwater contamination by petroleum hydrocarbons and 1,2-DCE have either been depleted or that the locations of highest soil contamination were not found during sampling activities.

Most inorganic constituents detected in SWMU 9 groundwater, surface water, soil, and sediment samples were within similar concentration ranges as background groundwater samples, which generally suggests that no significant groundwater impact has been identified for these chemicals. In some cases, soil concentration of metals were above background, but there did not appear to be any trend because higher concentrations were interspersed with lower ones.

Several organic substances were detected that are considered common or ubiquitous laboratory contaminants. Despite the use of proper sampling protocols and data validation to minimize analytical bias, methylene chloride, acetone, and bis(2-ethylhexyl)phthalate remained after data validation, in some cases in both site and background data sets, which does not suggest any pattern of contamination related to SWMU 9 activities for these substances.

Bromodichloromethane, dibromochloromethane, chloroform, vinyl acetate, and 2,4-D were not found in background samples and were each detected in only one or two samples from a given sampling medium. For these substances, which are rarely encountered at hazardous waste disposal sites, the relative significance of a single detection at levels below quantitation limits is unclear because they were not detected elsewhere in site-related samples and are not related to known site activities. Based on limited detection, it is not safe to conclude that there is a potential for widespread contamination for these compounds at SWMU 9.

4.4.7 Baseline Human Health Risk Assessment

This section presents the baseline HHRA for SWMU 9. It discusses the preliminary risk evaluation, data evaluation, toxicity assessment, exposure assessment, risk characterization, and remedial goal options. Conclusions about the baseline HHRA are presented in Section 4.4.7.8. The baseline HHRA presented in this section is a qualitative and quantitative assessment of actual or potential risks for SWMU 9. The methodologies and techniques used in the assessment are outlined in Section 3.2 of Appendix G.

4.4.7.1 Preliminary Risk Evaluation

Tables 4-95 and 4-96 summarize the preliminary risk evaluations for SWMU 9 for carcinogenic and noncarcinogenic risks, respectively. The risk ratio calculated assuming an industrial land use scenario is less than 1E-04 and 1.0 for carcinogenic and noncarcinogenic effects, respectively. The risk ratio calculated assuming a residential land use scenario is less than 1E-04 for carcinogenic effects (Table 4-95). However, the risk ratio calculated assuming a residential land use scenario is greater than 1.0 for noncarcinogenic effects (Table 4-96). Thus, a baseline human health risk assessment is necessary for SWMU 9. The preliminary contributors to the noncarcinogenic HI exceeding 1.0 are arsenic in sediment and antimony and thallium in surface water. Appendix G, Section 3.2.1 contains the methods used for preliminary risk assessment analysis. Lead will be evaluated separately using EPA's IEUBK Lead Model (v.0.99).

4.4.7.2 Data Evaluation

A list of COPCs was developed for each environmental medium, as necessary. Only those chemicals selected as COPCs were considered for evaluation in the quantitative risk assessment. A discussion of those chemicals identified as COPCs for each medium is provided in the following paragraphs. See Appendix G, Section 3.2.2 for a discussion of data evaluation procedures.

TABLE 4-95

PRELIMINARY RISK EVALUATION - CARCINOGENIC EFFECTS
SWMU 9
NAS KEY WEST

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residenital			Industrial	Residenital			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
INORGANICS											
Arsenic	ND	17.8	ND	0.43	0.43	0.045	3.8	NA	4E-05	NA	NA
PESTICIDES/PCBs											
4,4'-DDE	15	14.3	ND	1.9	1.9	0.2	17	8E-09	8E-09	NA	9E-10
4,4'-DDT	5	ND	ND	1.9	1.9	0.2	17	3E-09	NA	NA	3E-10
VOLATILE ORGANIC COMPOUNDS											
Methylene chloride	366	ND	ND	85	85	4.1	760	4E-09	NA	NA	5E-10
							Risk Sums by Medium	**2E-08**	**4E-05**	NA	**2E-09**
							Risk Sums by Use Scenario		**4E-05**		**2E-09**

*All soil and sediment metal concentrations are in mg/kg, all soil and sediment VOC, SVOC, and Pesticides/PCBs concentration are in µg/kg, and all water site data are in µg/L
ND = Not detected
NA = Not applicable

TABLE 4-96

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 9
NAS KEY WEST
PAGE 1 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
HERBICIDES											
2,4-dichlorophenoxyacetic acid (2,4-D)	0.13	ND	ND	780	780	61	20,000	2E-07	NA	NA	7E-09
Methyl parathion	ND	38.8	ND	20	20	9.1	510	NA	2E-04	NA	NA
INORGANICS											
Aluminum	4,790	3,710	ND	78,000	78,000	37,000	1,000,000	6E-02	5E-02	NA	5E-03
Antimony	ND	ND	5	31	31	15	820	NA	NA	3E-01	NA
Arsenic	ND	17.8	ND	23	23	11	610	NA	8E-01	NA	NA
Barium	46.8	19.8	7.3	5,500	5,500	2,600	140,000	9E-03	4E-03	3E-03	3E-04
Cadmium	7.15	0.62	ND	39	39	18	1,000	2E-01	2E-02	NA	7E-03
Chromium VI	69.55	11.6	ND	390	390	180	10,000	2E-01	3E-02	NA	7E-03
Cobalt	1.3	ND	1.1	4,700	4,700	2,200	120,000	3E-04	NA	5E-04	1E-05
Copper	49.6	14.7	ND	3,100	3,100	1,500	82,000	2E-02	5E-03	NA	6E-04
Cyanide	4.4	12.1	45.2	1,600	1,600	730	41,000	3E-03	8E-03	6E-02	1E-04
Iron	3,060	2,680	ND	23,000	23,000	11,000	610,000	1E-01	1E-01	NA	5E-03
Manganese	66.4	17.1	ND	390	390	180	10,000	2E-01	4E-02	NA	7E-03
Mercury	0.32	1.1	0.13	23	23	11	610	1E-02	5E-02	2E-02	5E-04
Nickel	6.6	5	1.6	1,600	1,600	730	41,000	4E-03	3E-03	2E-03	2E-04
Selenium	ND	7.3	ND	390	390	180	10,000	NA	2E-02	NA	NA
Silver	4.6	ND	ND	390	390	180	10,000	1E-02	NA	NA	5E-04
Thallium	ND	ND	10.1	6.3	6.3	2.9	160	NA	NA	4E+00	NA
Vanadium	14.8	13.2	ND	550	550	260	14,000	3E-02	2E-02	NA	1E-03
Zinc	298.5	38.3	ND	23,000	23,000	11,000	610,000	1E-02	2E-03	NA	5E-04
PESTICIDES/PCBs											
4,4'-DDT	5	ND	ND	39	39	18	1,000	1E-04	NA	NA	5E-06
Endosulfan I	8	ND	ND	470	470	220	12,000	2E-05	NA	NA	7E-07
Endrin	5	ND	ND	23	23	11	610	2E-04	NA	NA	8E-06
SEMIVOLATILE ORGANIC COMPOUNDS											
Naphthalene	960	ND	ND	3,100	3,100	1,500	82,000	3E-04	NA	NA	1E-05
VOLATILE ORGANIC COMPOUNDS											
Acetone	2,430	1,890	ND	7,800	7,800	3,700	200,000	3E-04	2E-04	NA	1E-05
Methylene chloride	366	ND	ND	4,700	4,700	2,200	120,000	8E-05	NA	NA	3E-06

TABLE 4-96

PRELIMINARY RISK EVALUATION - NONCARCINOGENIC EFFECTS
SWMU 9
NAS KEY WEST
PAGE 2 OF 2

Chemical*	Media Concentration (Maximum Detected Value)			Screening Values				Risk Ratio			
				Residential			Industrial	Residential			Industrial
	Soil	Sediment	Surface Water	Soil	Sediment	Surface Water	Soil	Soil	Sediment	Surface Water	Soil
VOLATILE ORGANIC COMPOUNDS (cont.)											
Toluene	5	ND	ND	16,000	16,000	750	410,000	3E-07	NA	NA	1E-08
Trans-1,2-dichloroethene	10	ND	ND	1,600	1,600	120	41,000	6E-06	NA	NA	2E-07
							Hazard Sums by Medium	**9E-01**	**1E-00**	**4E+00**	**3E-02**
							Hazard Sums by Use Scenario		**6E+00**		**3E-02**

*All inorganic soil and sediment site data are in mg/kg, all organic soil and sediment site data are in µg/kg, and all water site data are in µg/L.
ND = Not detected.
N = Not applicable.

4.4.7.2.1 Soils

Several metals, toluene, and several pesticides including 4,4'-DDE, 4,4'-DDT, endosulfan I, and endrin were detected in one or more surface soil samples collected at SWMU 9. Barium, chromium, cyanide, lead, manganese, nickel, silver, and vanadium along with two PAHs (naphthalene and 2-methylnaphthalene), two VOCs (acetone and methylene chloride), and three pesticides (4,4'-DDT, delta-BHC, and endrin) were detected in one or more subsurface soil samples collected at SWMU 9. The occurrence and distribution of chemicals in surface and subsurface soils are presented in Tables 4-97 through 4-100. COPC selection results, summary statistics, and representative concentrations for chemicals detected in SWMU 9 environmental media are also presented on these tables. The following chemicals were selected as COPCs for SWMU 9 surface and subsurface soils:

SEDIMENT		SURFACE WATER	
Inorganics	Organics	Inorganics	Organics
Cadmium	None	None	Delta-BHC**
Iron			
Lead*			
Manganese			

Lead (*) will be evaluated using the IEUBK Lead Model (v. 0.99) for surface soil exposure. No quantitative toxicity values for delta-BHC (**) are available; therefore, delta-BHC will be evaluated qualitatively in the uncertainty section.

Cadmium, iron, and manganese were selected as COPCs in surface soils. Cadmium was detected in two out of five samples with levels exceeding ten times the background concentrations. The maximum exceeded was by two times the residential soil RBC screening value. Manganese and iron were detected in all five surface soil samples. Iron levels slightly exceeded background concentrations and the maximum (3,060 mg/kg) exceed the residential soil RBC value (2,300 mg/kg). Manganese levels exceeded background and the maximum value exceeded (by two times) the residential soil RBC screening value. Uncertainty is associated with the selection of iron as a COPC because it may represent background concentrations, potentially overestimating the risk.

Delta-BHC (which will be evaluated in the uncertainty section) was detected infrequently (one out of six samples analyzed) in subsurface soil samples at a range comparable to background levels.

TABLE 4-97

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE SOIL SWMU 9 (mg/kg) NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	11/11	120-4,250	2,130	5/5	1,170-4,790	3,250	7,800	4,790	N	A
Barium	12/12	4.4-17.7	11	5/5	14.5-46.8	25.40	550	46.80	N	A
Cadmium	4/12	0.11-0.45	0.173	2/5	2.1-7.15	1.95	3.9	7.2	Y	C
Calcium	11/11	265,000-449,000	362,000	5/5	316,000-465,000	372,500	–	439,889	N	D
Chromium	12/12	1.9-15.5	6.22	5/5	7.2-69.55	22.39	7,800	69.6	N	A
Cobalt	7/12	0.22-0.51	0.341	5/5	0.33-1.3	0.83	470	1.30	N	A
Copper	11/12	1.3-15.6	5.2	5/5	6.9-49.6	19.57	310	49.6	N	A
Cyanide	0/5	Not detected	–	2/5	2.2-2.6	1.04	160,000	2.6	N	A
Iron	11/11	98.1-2,260	1,290	5/5	1,170-3,060	2,337	2,300	3,060	Y	C
Lead	11/12	0.65-48.3	16.8	5/5	7.4-264.95	75.6	–	265	Y	H
Magnesium	11/11	1,340-24,600	7,800	5/5	2,310-6,500	4,768	–	6,500	N	D
Manganese	11/11	2.6-33.7	19.4	5/5	12.4-66.4	35.6	39	66.4	Y	C
Mercury	2/12	0.048-0.08	0.033	2/5	0.06-0.32	0.10	2.3	0.32	N	A
Nickel	8/12	0.63-4.1	1.63	5/5	3.6-6.6	4.71	160	6.1	N	A
Potassium	11/11	48.6-944	356	5/5	117-621	343.60	–	621	N	D
Silver	0/5	Not detected	–	3/5	1.16-4.6	1.57	39	4.6	N	A
Sodium	11/11	834-18,700	4,620	5/5	818-2,180	1,427	–	2,180	N	D
Vanadium	12/12	0.8-8.8	3.71	5/5	4.45-14.8	10.13	55	14.8	N	A
Zinc	12/12	0.63-89.1	19	5/5	16.5-298.5	93.10	2,300	298.50	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max<2XBKGDAVE.

TABLE 4-98

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs ORGANICS IN SURFACE SOIL SWMU 9 (µg/kg) NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDE	3/8	3.9-53.3	5.71	2/6	9-15	7.04	1,900	15	N	A
4,4'-DDT	4/8	2.6-9.3	7.62	1/6	2	4.77	1,900	2	N	A
Endosulfan I	0/8	Not detected	–	1/6	8	3.19	47,000	8	N	A
Endrin	0/8	Not detected	–	1/6	5	5.23	2,300	5	N	A
VOLATILE ORGANIC COMPOUNDS										
Toluene	1/2	1	6.71	1/5	5	2.20	1,600,000	5	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.
H = COPC, evaluated using IEUBK lead model, Max<2XBKGDAVE.

TABLE 4-99

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SUBSURFACE SOIL SWMU 9 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	11/11	120-4,250	2,130	2/5	179-272	100.57	100,000	272	N	A
Barium	12/12	4.4-17.7	11	5/5	6.1-9.1	7.35	14,000	9.01	N	A
Calcium	11/11	265,000-449,000	362,000	5/5	386,500-407,000	395,700	–	403,689	N	D
Chromium	12/12	1.9-15.5	6.22	5/5	2.1-4.9	3.16	100,000	4.90	N	A
Cyanide	0/5	Not detected	–	2/5	1.5-4.4	1.24	4,100	4	N	A
Iron	11/11	98.1-2,260	1,290	5/5	31.9-295	103.42	61,000	295	N	A
Lead	11/12	0.65-48.3	16.8	5/5	1.3-2.25	1.61	–	2	N	G
Magnesium	11/11	1,340-24,600	7,800	5/5	672-1,560	1,038	–	1,560	N	D
Manganese	11/11	2.6-33.7	19.4	5/5	0.63-4.05	2.46	1,000	4	N	A
Nickel	8/12	0.63-4.1	1.63	5/5	0.53-2.1	1.14	4,100	2.10	N	A
Potassium	11/11	48.6-944	356	5/5	25.2-36.05	30.95	–	36	N	D
Silver	0/5	Not detected	–	3/5	0.22-0.76	0.29	1,000	0.76	N	A
Sodium	11/11	834-18,700	4,620	5/5	955-1,530	1,272	–	1,530	N	D
Vanadium	12/12	0.8-8.8	3.71	5/5	0.43-2.9	1.19	1,400	2.90	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-100

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SUBSURFACE SOIL SWMU 9 (μg/kg)
NAS KEY WEST

Chemical	Background			Site			Industrial Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDT	4/8	2.6-9.3	7.62	1/6	5	2.67	17,000	5	N	A
Delta-BHC	0/8	Not detected	–	1/6	2	1.17	–	2	Y	F
Endrin	0/8	Not detected	–	1/6	2	2.08	61,000	2	N	A
SEMIVOLATILE ORGANIC COMPOUNDS										
2-methylnaphthalene	0/11	Not detected	–	1/5	2,065	574.60	82,000,000	2,065	N	A
Naphthalene	0/11	Not detected	–	1/5	960	353.60	8,200,000	960	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	1/12	1	3.67	4/5	12-2,430	567.30	20,000,000	2,430	N	A
Methylene chloride	6/12	0.11-14	2.80	2/5	171-366	108.20	760,000	366	N	A
Trans-1,2-dichloroethene	0/12	Not detected	–	2/5	3-10	150.90	4,100,000	10	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

4.4.7.2.2 Sediment and Surface Water

Several metals and acetone were detected in one or more sediment samples collected at SWMU 9. Antimony, barium, cobalt, cyanide, mercury, nickel, and thallium along with 2,4-dichlorophenoxyacetic acid 2,4-D were detected in surface-water samples collected at SWMU 9. The occurrence and distribution of chemicals in sediment and surface water are presented in Tables 4-101 through 4-104. COPC selection results, summary statistics, and representative concentrations for chemicals detected in SWMU 9 environmental media are also presented on these tables. The following chemicals were selected as COPCs for SWMU 9 sediment and surface-water:

SEDIMENT		**SURFACE WATER**	
Inorganics	Organics	Inorganics	Organics
Arsenic	Delta-BHC*	Thallium	None
Iron			

No quantitative toxicity values for this chemical (*) are listed; therefore, delta-BHC will be evaluated qualitatively in the uncertainty section. Arsenic was detected in two of the five sediment samples analyzed at concentrations that exceeded background and residential soil RBC screening criteria. Iron was detected in all five sediment samples slightly exceeding background and the residential soil RBC. Therefore arsenic and iron were selected as COPCs. The iron concentration in sediment is similar to background concentrations. Uncertainty is associated with the selection of iron as a COPC, because it may represent background concentrations, potentially overestimating the risk. None of the organics detected in sediment were selected as COPCs, except delta-BHC which does not have a quantitative toxicity value (i.e., RfD or SF), and will be discussed in the uncertainty section.

Thallium was detected in all six surface-water samples analyzed at SWMU 9. The levels of thallium in surface water (5.6 µg/L to 10.1 µg/L) were comparable to background concentrations (7.4 µg/L to 12 µg/L) and exceeded the residential tap water RBC of 0.29 µg/L. Thallium was selected as a COPC. Uncertainty is associated with the selection of thallium as a COPC because it may represent background concentrations, potentially overestimating the risk. None of the organics detected in sediment were selected as COPCs. The RBCs for tap water ingestion were used as a point of comparison because RBCs for typical surface water exposure (i.e., recreational exposures) are not currently published by EPA. It should be noted that surface water exposure (industrial and recreational) is generally less intensive than tap water exposure (i.e., exposures resulting from the typical domestic use of a water supply). Thus, the use of the tap water RBCs to select surface-water COPCs is very conservative. None of the organics detected in the surface water samples were selected as COPCs.

TABLE 4-101

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
INORGANICS IN SEDIMENT SWMU 9 (mg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Aluminum	4/4	497-3,350	2,042	5/5	774-3,710	2,361	7,800	3,710	N	A
Arsenic	2/4	1.5-1.6	1.71	2/5	12.6-17.8	7.85	0.43	17.80	Y	C
Barium	5/5	5-15.2	9.88	5/5	5.7-19.8	10.24	550	19.80	N	A
Cadmium	2/5	0.12-0.9	0.42	3/5	0.28-0.62	0.33	3.9	0.62	N	A
Calcium	4/4	223,000-393,000	325,250	5/5	130,000-209,000	172,600	–	209,000	N	D
Chromium	5/5	2.1-11.7	6.94	5/5	3.3-11.6	7.50	7,800	11.6	N	A
Copper	5/5	0.76-34.6	9.01	5/5	4.7-14.7	11	310	14.7	N	A
Cyanide	0/5	Not detected	–	1/5	12.1	2.74	160,000	12.1	N	A
Iron	4/4	363-2,600	1,305	5/5	762-2,680	1,722	2,300	2,680	Y	C
Lead	4/5	5.5-56.5	24.65	5/5	6.4-23.1	14.10	–	23.10	N	A
Magnesium	4/4	4,680-20,000	12,425	5/5	7,600-11,500	9,720	–	11,500	N	D
Manganese	4/4	14.9-38.5	21.95	5/5	6.2-17.1	11.98	39	17.1	N	A
Mercury	0/5	Not detected	–	1/5	1.1	0.30	2.3	1.1	N	A
Nickel	4/5	0.7-5.5	2.49	5/5	1.5-5	3.16	160	5	N	A
Potassium	4/4	517-4,180	1,469	5/5	1,040-2,740	1,722	–	2,740	N	D
Selenium	1/5	0.24	1.04	1/5	7.3	2.83	39	7.30	N	A
Sodium	4/4	5,500-86,900	28,788	5/5	20,400-52,400	35,140	–	52,400	N	D
Vanadium	5/5	2.8-8.9	4.84	5/5	4.7-13.2	8.72	55	13.2	N	A
Zinc	5/5	3.5-58.2	30.40	5/5	12.5-38.3	23.26	2,300	38.3	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-102

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SEDIMENT SWMU 9 (µg/kg)
NAS KEY WEST

Chemical	Background			Site			Residential Soil Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
HERBICIDES										
Methyl parathion	0/1	–	–	2/5	14.8-38.8	16.76	2,000	38.8	N	A
VOLATILE ORGANIC COMPOUNDS										
Acetone	3/5	4-120	34.3	2/5	275-1,890	435.30	780,000	1,890	N	A
PESTICIDES/PCBs										
4,4'-DDE	0/2	–	–	2/5	6.4-14.3	11.61	1,900	14.3	N	A
Delta-BHC	0/2	–	–	2/5	11.3-14.2	8.92	–	14.2	Y	F

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-103

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs
ORGANICS IN SURFACE WATER SWMU 9 (μg/L)
NAS KEY WEST

Chemical	Background		Site			Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Frequency of Detection	Range of Positive Detection	Average				
HERBICIDES									
2,4-D	0/5	Not detected	1/6	0.13	0.10	6.10	0.11	N	A

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

TABLE 4-104

OCCURRENCE, DISTRIBUTION AND SELECTION OF COPCs INORGANICS IN SURFACE WATER SWMU 9 (μg/L) NAS KEY WEST

Chemical	Background			Site			Tap Water Risk-Based Concentration*	Representative Concentration	COPC	Basis of COPC Selection**
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Antimony	2/5	3.5-7.3	2.9	6/6	2.9-5.3	3.82	1.5	4.7	N	G
Barium	6/6	5.8-16.3	9.05	6/6	6.7-7.3	6.90	260	7.1	N	A
Calcium	5/5	105,000-326,000	200,200	6/6	309,000-346,000	336,167	–	346,000	N	D
Cobalt	0/7	Not detected	–	1/6	1.1	0.52	220	0.8	N	A
Cyanide	1/7	0.11	1.56	1/6	45.2	8.12	73	45.2	N	A
Magnesium	5/5	193,000-1,360,000	684,000	6/6	1,160,000-1,220,000	1,178,333	–	1,196,054	N	D
Mercury	1/7	0.48	0.12	1/6	0.13	0.06	1.1	0.1	N	A
Nickel	0/7	Not detected	–	1/6	1.6	0.81	73	1.2	N	A
Potassium	5/5	70,600-418,000	227,000	6/6	351,000-364,000	353,833	–	357,997	N	D
Sodium	5/5	1,720,000-11,800,000	5,980,000	6/6	9,860,000-10,300,000	9,986,667	–	10,119,171	N	D
Thallium	2/7	7.4-12	4.88	6/6	5.6-10.1	8.62	0.29	10.1	Y	C

*RBC = Risk-based concentration, target risk = 0.1, carcinogenic risk = 1E-06.

**A = Not COPC, Max<RBC.
B = COPC, Max>RBC, organics only.
C = COPC, Max>RBC and Max>2XBKGDAVE, inorganics only.
D = Not COPC, nutrient/mineral.
E = COPC, same family as a selected COPC.
F = COPC, evaluated qualitatively in the uncertainty section.
G = Not COPC, Max>RBC but Max<2XBKGDAVE, inorganics only.

Methods for selection of COPCs and development of representative concentrations, and other data evaluation procedures are presented in Section 3.2.2 of Appendix G.

4.4.7.3 Toxicity Assessment

The toxicological profiles for selected COPCs at SWMU 9 are shown in Appendix A. All relevant quantitative and qualitative toxicity assessment information and methods were presented in Section 3.2.3 of Appendix G.

4.4.7.4 Exposure Assessment

The COPCs selected for each environmental medium sampled at SWMU 9 are presented in Section 4.4.7.2. The potential receptors identified in Appendix G, Section 3.2.4.2, applicable to media sampled at SWMU 9 include current adolescent and adult trespassers, current occupational workers, current site maintenance workers, future excavation workers, and future residents. Consequently, with the exception of the excavation worker, all potential receptors and exposure pathways discussed in Section 3.2.4 of Appendix G were evaluated quantitatively. No COPCs with quantitative toxicity values (i.e., RfDs or SFs) were selected for subsurface soils. All exposure parameters, exposure routes, and other relevant exposure assessment information was presented in Section 3.2.4 of Appendix G. Example calculations for estimated intakes are also presented in Appendix A.

4.4.7.5 Risk Characterization

This section presents the results of the quantitative risk assessment. Table 4-105 presents the estimated cumulative carcinogenic and noncarcinogenic risks for hypothetical future residents, trespasser adults, trespasser adolescents, maintenance workers, and occupational workers at SWMU 9. The total risk for each exposure route and the cumulative risk across all exposure pathways are provided. The risks associated with a particular COPC are provided in the risk assessment spreadsheets in Appendix A. This section discusses the human health risk assessment in three parts:

- Carcinogenic Risks
- Noncarcinogenic Risks
- The results of the evaluation of lead in surface soils using the IEUBK Model

Additionally, a comparison of groundwater results to screening criteria and a special note concerning fish are presented.

TABLE 4-105

CUMULATIVE RISKS
SWMU 9*
NAS KEY WEST
PAGE 1 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
INCREMENTAL CANCER RISK						
SURFACE SOIL						
Incidental Ingestion	**	**	**	**	NA	**
Dermal Contact	**	**	**	**	NA	**
Inhalation of Fugitive Dust	1E-08	7E-11	9E-11	1E-10	NA	2E-09
Subtotal of Media	1E-08	7E-11	9E-11	1E10	NA	2E-09
SUBSURFACE SOIL						
Incidental Ingestion	NA	NA	NA	NA	**	NA
Dermal Contact	NA	NA	NA	NA	**	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
SEDIMENT						
Incidental Ingestion	1E-05	1E-06	1E-06	NA	NA	NA
Dermal Contact	5E-05	1E-05	9E-06	NA	NA	NA
Subtotal of Media	6E-05	1E-05	1E-05	NA	NA	NA
SURFACE WATER						
Incidental Ingestion	**	**	**	NA	NA	NA
Dermal Contact	**	**	**	NA	NA	NA
Subtotal of Media	**	**	**	NA	NA	NA
TOTAL	6E-05	1E-05	1E-05	1E-10	**	2E-09
HAZARD INDEX						
SURFACE SOIL						
Incidental Ingestion	5E-01	4E-03	8E-03	2E-03	NA	2E-02
Dermal Contact	1E-01	5E-03	7E-03	2E-03	NA	2E-02
Inhalation of Fugitive Dust	1E-03	4E-06	8E-06	4E-06	NA	8E-05
Subtotal of Media	6E-01	9E-03	2E-02	4E-03	NA	4E-02
SUBSURFACE SOIL						
Incidental Ingestion	NA	NA	NA	NA	**	NA
Dermal Contact	NA	NA	NA	NA	**	NA
Inhalation of Fugitive Dust	NA	NA	NA	NA	**	NA
Subtotal of Media	NA	NA	NA	NA	**	NA
SEDIMENT						
Incidental Ingestion	3E-01	1E-02	2E-02	NA	NA	NA
Dermal Contact	3E-01	1E-01	1E-01	NA	NA	NA
Subtotal of Media	6E-01	1E-01	1E-01	NA	NA	NA

TABLE 4-105

CUMULATIVE RISKS
SWMU 9*
NAS KEY WEST
PAGE 2 OF 2

Exposure Route	Resident	Trespasser Adult	Trespasser Adolescent	Maintenance Worker	Excavation Worker	Occupational Worker
HAZARD INDEX (cont.)						
SURFACE WATER						
Incidental Ingestion	3E-01	3E-02	5E-02	NA	NA	NA
Dermal Contact	2E-01	1E-02	2E-02	NA	NA	NA
Subtotal of Media	5E-01	4E-02	7E-02	NA	NA	NA
Total	2E+00	1E-01	2E-01	4E-03	**	4E-02

* = Chemical-specific risks are presented in Appendix A.
** = Either no COPCs were selected or the COPCs selected for this pathway did not have applicable toxicity values.
NA = Not applicable, pathway is not applicable for the respective media.

4.4.7.5.1 Carcinogenic Risks

The estimated carcinogenic risk for future residents (6E-05), trespasser adult (1E-05), and trespasser adolescent (1E-05) is within EPA's "target risk range" of 1E-04 to 1E-06. Dermal contact with sediment for the future resident, adult trespasser, and adolescent trespasser has an incremental cancer risks of 5E-05, 1E-05, and 9E-06, respectively. This exposure route contributes the most to the cumulative carcinogenic risk for these three receptors. The dermal contact with COPC route is associated with high uncertainty based on the $ABSEFF_{oral}$ presented in Appendix G, Section 3.2.3.4. The principal COPC contributing to these cancer risks was arsenic in sediment. The estimated carcinogenic risks for the maintenance worker (1E-10) and occupational worker (2E-09) were below 1E-06. The estimated carcinogenic risks for the excavation worker were not estimated because no COPCs were selected in subsurface soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.4.7.5.2 Noncarcinogenic Risks

The cumulative HI for the hypothetical future resident (2E+00) exceeds 1.0, a benchmark below which adverse noncarcinogenic health effects are not anticipated under conditions established in the exposure assessment. The principal COPCs contributing to the noncarcinogenic risk are cadmium (HQ = 0.27), iron (HQ = 0.14), and manganese (HQ = 0.18) in surface soil; arsenic (HQ = 0.55) in sediment; and thallium (HQ = 0.45) in surface water. The target organs for arsenic and thallium are the skin. However, these COPCs add up to an HI of approximately 1.0. Therefore, no HI based on the same target organ would exceed 1.0 for the hypothetical future resident. The cumulative HIs for adolescent trespassers, adult trespassers, maintenance workers, and occupational workers at SWMU 9 are less than 1.0. The estimated noncarcinogenic risks for the excavation worker were not estimated because no COPCs were selected in subsurface soils. Chemical-specific risks for COPCs are presented in Appendix A.

4.4.7.5.3 IEUBK Lead Results

The IEUBK Lead Model (v. 0.99) was used to characterize potential effects associated with exposure to media containing lead. The model was run two ways: using the representative concentration and using the average concentration. The purpose of this was to give the risk manager a range of risks based on a conservative exposure (using the representative concentration) and an average exposure (using the average concentration). 1.) Using the representative concentration - Based on model results, 3.05 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL (EPA, 1994). The model inputs assumed were the default parameter values, 265 mg/kg lead in site-related soils, and 2.1 µg/L lead in groundwater. 2.) Using the average concentration - Based on model results, 0.06 percent of residential children exposed under similar conditions might have blood-lead levels above 10 µg/dL. This is less than the protective guideline of 5 percent for the maximum proportion of individuals with blood levels above 10 µg/dL (EPA, 1994). The model inputs assumed were default parameter values, 75.6 mg/kg lead in site-related soils, and 2.1 µg/L lead in groundwater. The IEUBK histograms for background and SWMU 9 exposures are presented in Appendix A.

4.4.7.5.4 Groundwater and the Quantitative Risk Assessment

Groundwater was not evaluated as part of the baseline HHRA because it is classified as Class G-III, nonpotable, by FDEP. As discussed in Section 3 and in Appendix G, Section 3.2.2.2, groundwater obtained from the surficial aquifer at Key West has a high salinity, and the public water supply obtained from the mainland is officially designated as the only potable source. No freshwater public or registered domestic wells exist, although domestic wells are reportedly used for purposes such as flushing water. Although treatment could possibly be used to improve water quality, the local water authority regulates all potable supplies in the Keys.

A preliminary comparison of unfiltered groundwater concentrations at SWMU 9 versus tap water RBCs (EPA, 1995b) and MCLs (EPA, 1995c) is presented in Tables 4-106 and 4-107 for inorganics and organics, respectively. The results of this preliminary comparison for SWMU 9 are:

- The maximum values of several VOCs including 1,1,2-TCA, 1,1-DCE, 1,2-DCA, 1,2-DCP, benzene, carbon tetrachloride, cis-1,2-DCE, methylene chloride, PCE, trans-1,2-DCE, TCE, and vinyl chloride and an SVOC, bis(2-ethylhexyl)phthalate, exceeded MCL and RBC screening criteria. Most of the VOCs were detected at a frequency of 10 percent of the samples analyzed. Exceptions to this include cis-1,2-DCE and trans-1,2-DCE (detected in 50 percent of the samples analyzed); benzene and TCE (detected in 20 percent of the samples analyzed), and methylene chloride (detected in 30 percent of the samples analyzed). The maximums of these VOCs exceeded (i.e., generally between 2 and 1,000 times) RBC screening values. The maximums of these VOCs exceeded (i.e., generally between 2 and 100 times) MCLs. The maximum for all these VOCs was 13.5 µg/L, except benzene (56 µg/L), cis-1,2-DCE (1,560 µg/L), trans-1,2-DCE (3,060 µg/L), methylene chloride (92.2 µg/L), and TCE (44 µg/L). The lowest tap water RBC of all these VOCs was 0.019 µg/L (vinyl chloride). The lowest MCL was also for vinyl chloride (2 µg/L). Note: the VOCs with a maximum concentration of 13.5 µg/L are associated with laboratory results of a questionable nature (See Section 4.4.6).

TABLE 4-106

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs INORGANICS IN GROUNDWATER SWMU 9 (µg/L) NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
Arsenic	3/6	4.1-11.9	4.33	3/8	5-8	3.78	50	N	0.045	Y
Barium	6/6	6.6-19.45	13.9	8/8	5.4-11.7	7.63	2,000	N	2,600	N
Calcium	3/3	114,000-244,000	180,583	8/8	61,900-198,000	115,100	NL	NA	NL	NA
Cyanide	2/3	2.4-5.525	2.76	5/8	0.83-6.6	1.48	200	N	730	N
Iron	2/3	76.2-97.4	62.6	2/8	196-360	78.57	NL	NA	11,000	N
Lead	1/5	2.5	1.19	1/27	2.4	2.10	15	N	NL	NA
Magnesium	3/3	123,750-820,250	433,000	8/8	24,150-377,000	121,019	NL	NA	NL	NA
Manganese	2/3	3.7-10.3	4.87	6/8	0.97-8.5	2.94	NL	NA	180	N
Potassium	3/3	38,850-181,750	119,000	8/8	2,670-142,000	39,956	NL	NA	NL	NA
Selenium	0/6	Not detected	–	2/8	4.9-6	3.16	50	N	180	N
Silver	0/6	Not detected	–	1/8	6	1.06	NL	NA	180	N
Sodium	3/3	982,250-6,615,000	3,670,000	8/8	43,400-3,290,000	857,050	NL	NA	NL	NA
Vanadium	0/6	Not detected		3/8	0.89-4.4	1.00	NL	NA	260	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum Contaminant Level (EPA, 1995c).
**RBC = Risk-Based Concentration (EPA, 1995b).

TABLE 4-107

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs
ORGANICS IN GROUNDWATER SWMU 9 (µg/L)
NAS KEY WEST

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
PESTICIDES/PCBs										
4,4'-DDT	0/6	Not sampled	–	1/8	0.26	0.09	NL	NA	0.2	Y
Beta-BHC	0/6	Not sampled	–	1/8	0.03	0.05	NL	NA	0.037	N
Delta-BHC	0/6	Not sampled	–	1/8	0.43	0.08	NL	NA	NL	NA
Dieldrin	0/6	Not sampled	–	1/8	0.19	0.09	NL	NA	0.0042	Y
Endrin	0/6	Not sampled	–	1/8	0.25	0.09	2	N	11	N
SEMIVOLATILE ORGANIC COMPOUNDS										
1,4-dichlorobenzene	0/4	Not detected	–	9/39	1-2	3.29	75	N	0.44	Y
1-methylnaphthalene	0/0	Not sampled	–	5/20	10-110	14.53	NL	NA	1,500	N
2-methylnaphthalene	0/4	Not detected	–	3/28	53-130	11.52	NL	NA	1,500	N
Bis(2-ethylhexyl)phthalate	0/4	Not detected	–	1/8	9	5.50	6	Y	4.8	Y
Chlorodibromomethane	0/0	Not sampled	–	8/47	0.32-13.50	9.93	80	N	0.13	Y
Naphthalene	1/4	2	4.09	13/57	2-110	10.61	NL	NA	1,500	N
VOLATILE ORGANIC COMPOUNDS										
1,1,1-trichloroethane	0/3	Not detected	–	8/82	2-13.50	6.83	200	N	1,300	N
1,1,2,2-tetrachloroethane	0/3	Not detected	–	7/82	2-13.50	6.79	NL	NA	0.052	Y
1,1,2-trichloroethane	0/3	Not detected	–	7/82	2-13.50	6.79	5	Y	0.19	Y
1,1-dichloroethane	0/3	Not detected	–	7/82	2-13.50	6.79	NL	NA	810	N
1,1-dichloroethene	0/3	Not detected	–	8/82	2-13.50	6.80	7	Y	0.044	Y
1,2-dichloroethane	0/3	Not detected	–	7/82	2-13.50	6.79	5	Y	0.12	Y
1,2-dichloroethene (total)	0/1	Not detected	–	2/24	25-35	3.29	70	N	55	N
1,2-dichloropropane	0/3	Not detected	–	7/82	2-13.50	6.79	5	Y	0.16	Y
2-butanone	2/3	7-32	14.7	7/47	10-67.50	49.31	NL	NA	1,900	N
2-hexanone	0/3	Not detected	–	8/51	2.32-67.50	45.78	NL	NA	NL	NA
4-methyl-2-pentanone	0/3	Not detected	–	7/51	10-67.50	45.83	NL	NA	NL	NA
Acetone	1/3	5	5	20/51	5-100	50.37	NL	NA	3,700	N
Benzene	0/3	Not detected	–	14/82	1.60-56	8.66	5	Y	0.36	Y
Bromodichloromethane	0/3	Not detected	–	8/82	0.20-13.50	6.78	80	N	0.17	Y
Bromoform	0/3	Not detected	–	7/82	2-13.50	6.79	80	N	0.17	Y
Bromomethane	0/3	Not detected	–	7/82	2-13.50	6.91	NL	NA	8.7	Y
Carbon disulfide	0/3	Not detected	–	10/51	0.11-67.50	45.69	NL	NA	1,000	N

TABLE 4-107

OCCURRENCE, DISTRIBUTION AND COMPARISON TO MCLs AND TAP WATER RBCs
ORGANICS IN GROUNDWATER SWMU 9 (μg/L)
NAS KEY WEST
PAGE 2 OF 2

Chemical	Background			Site			MCL*	Maximum Exceeds MCL?	Tap Water RBC**	Maximum Exceeds RBC?
	Frequency of Detection	Range of Positive Detection	Average	Frequency of Detection	Range of Positive Detection	Average				
VOLATILE ORGANIC COMPOUNDS (cont.)										
Carbon tetrachloride	0/3	Not detected	--	7/82	2-13.50	6.79	5	Y	0.16	Y
Chlorobenzene	0/3	Not detected	--	7/82	2-13.50	6.79	NL	NA	39	N
Chloroethane	0/3	Not detected	--	7/82	2-13.50	6.91	NL	NA	8,600	N
Chloroform	0/3	Not detected	--	8/82	1.07-13.50	6.79	80	N	0.15	Y
Chloromethane	0/3	Not detected	--	7/82	2-13.50	6.91	NL	NA	1.4	Y
Cis-1,2-dichloroethene	0/3	Not detected	--	26/54	2-1560	154.57	70	Y	61	Y
Cis-1,3-dichloropropene	0/3	Not detected	--	7/82	2-13.50	6.79	NL	NA	0.077	Y
Ethylbenzene	0/3	Not detected	--	11/82	2-70	8.74	700	N	1,300	N
Isopropyl alcohol	0/0	Not sampled	--	1/1	23	23.00	NL	NA	NL	N
Methylene chloride	2/3	1	1.5	28/82	0.42-92.20	8.75	5	Y	4.1	Y
Styrene	0/3	Not detected	--	7/51	10-67.50	45.40	100	N	1,600	N
Tetrachloroethene	0/3	Not detected	--	8/82	0.07-13.50	6.78	5	Y	1.1	Y
Toluene	0/3	Not detected	--	12/82	0.06-13.50	6.72	1,000	N	750	N
Trans-1,2-dichloroethene	0/2	Not detected	--	29/62	2-3060	287.76	100	Y	120	Y
Trans-1,3-dichloropropene	0/3	Not detected	--	7/82	2-13.50	6.79	70	N	0.077	Y
Trichloroethene	0/3	Not detected	--	15/82	1.50-44	7.83	5	Y	1.6	Y
Trichlorofluoromethane	0/3	Not detected	--	2/39	3	2.36	NL	NA	1,300	N
Vinyl acetate	0/3	Not detected	--	9/51	3-67.50	45.70	NL	NA	37,000	N
Vinyl chloride	0/3	Not detected	--	7/82	2-13.50	6.91	2	Y	0.019	Y
Xylenes (total)	0/3	Not detected	--	10/82	2-131.60	50.39	10,000	N	12,000	N

NA = Not applicable.
NL = Not listed.
*MCL = Maximum Contaminant Level (EPA, 1995c).
**RBC = Risk-Based Concentration (EPA, 1995b).

- The maximum values of arsenic, 4,4'-DDT, dieldrin, and several VOCs, including 1,1,2,2-tetrachloroethane, bromodichloromethane, bromoform, bromomethane, chloroform, chloromethane, cis-1,3-DCP, and 1,4-DCB exceeded tap water RBC screening criteria. Arsenic was detected in three out of eight samples analyzed. The three detections of arsenic were collected in the 1996 sampling round. Arsenic was detected above background levels at concentrations ranging from 5 µg/L to 7.6 µg/L, well exceeding the tap water RBC of 0.045 µg/L, but less than the MCL of 50 µg/L. The pesticides, 4,4'-DDT and dieldrin were each detected in one sample out of eight samples analyzed. The concentration of 4,4'-DDT (0.26 µg/L) slightly exceeded the tap water RBC value of 0.2 µg/L. The concentration of dieldrin (0.19 µg/L) exceeded the tap water RBC value of 0.0042 µg/L. The VOCs were generally detected at a frequency of 10 percent of the samples analyzed. The VOCs were generally detected in the 1995 sampling round. The maximums of these VOCs exceeded (i.e., generally between 3 and 100 times) RBC screening values. The maximums for all these VOCs except 1,4-DCB were 13.5 µg/L. 1,4-DCB was detected at a maximum of 2 µg/L. The lowest tap water RBC of all these VOCs was 0.052 µg/L (1,1,2,2-tetrachloroethane). Note: the VOCs with a maximum concentration of 13.5 µg/L are associated with laboratory results of a questionable nature (see Section 4.4.6).

4.4.7.5.5 <u>Fish and the Quantitative Risk Assessment</u>

Fish and shellfish at SWMU 9 were not considered a human health concern because the inlet is open to the ocean and wide-ranging fish would spend only a minor portion of time in the inlet. Mangrove oysters were sampled adjacent to the inlet and did not reveal contaminants above background. A more complete discussion of this subject is presented in Section 3.2.2.3 of Appendix G.

4.4.7.6 Uncertainties for SWMU 9

Beyond the uncertainties associated with the HHRA process discussed in Appendix G, the following uncertainties should be considered in any evaluation of SWMU 9 risk assessment results:

- The uncertainty associated with the dermal exposure is high because of the derivation of the dermal reference dose (see Appendix G, Section 3.2.3.4). Dermal exposure is a primary contributor to the cumulative cancer risk and noncancer HI (via sediment and surface water) for the hypothetical future residential receptors. The uncertainty associated with the dermal exposure route may overestimate the risk at SWMU 9.

- Iron was selected as a COPC in surface soils and sediment, but it was detected at levels in SWMU 9 that slightly exceed background levels. The inclusion of iron as a site-related sediment COPC could overestimate the quantitative risk at SWMU 9 for the hypothetical future residential receptor. Additionally there is uncertainty associated with the oral RfD for iron.

- Use of residential RBCs (sediment) and tap water RBCs (surface water) probably influences the selection of COPCs at the site by potential designated chemicals as COPCs that do not contribute significantly to the quantitative risk at SWMU 9 (i.e., iron in sediment). This bias is based on the fact that sediment is generally well below the intakes that a receptor would be exposed to under a true residential soil and groundwater exposure pathway.

- Delta-BHC did not have listed toxicity values for use in the quantitative risk assessment, therefore no risks were estimated for exposure to the COPCs. Delta-BHC was detected in one sample at levels comparable to other pesticides detected in subsurface soils and sediment.

4.4.7.7 Chemicals of Concern and Remedial Goal Options

At SWMU 9, no COCs were selected for remedial clean-up goal options (RGO) analysis because in no instance did any receptor scenario have a total risk (combined across pathways) exceeding a level of concern (1E-04 cancer risk or HI of 1.0). Section 3.2.7 of Appendix G further describes the ARARs, TBCs, and risk-based criteria used in selecting COCs (RCRA Corrective Action Levels, FDEP SCGs, and AWQC).

4.4.7.8 Conclusions

The primary objectives of the investigation at SWMU 9 were to identify existing nature and extent of contamination (after an interim remedial action at the SWMU) in the onsite media, to provide a baseline HHRA of COPCs identified in those media, and to develop an ecological risk assessment.

Noncarcinogenic and carcinogenic human health risks were estimated for potential current (trespasser, maintenance worker, and occupational worker) and hypothetical future (residents) receptors.

COPCs in SWMU 9 media were not present at sufficient concentrations to cause adverse noncarcinogenic health effects to any current potential receptor. COPCs were present, however, at concentrations indicating that adverse noncarcinogenic health effects might occur under the conditions evaluated in the baseline human health risk assessment for the hypothetical future resident. The cancer risks estimated for any current or future potential receptors were below or within the 1E-04 to 1E-06 target risk range, often used by EPA in setting standards and criteria and in evaluating the need for environmental remediation.

The future land uses planned for this site [i.e., military base with restricted access or zoned future limited access because of existing conditions (e.g., areas near the active airstrip)] do not include residential land use for the foreseeable future.

The results of the baseline HHRA for all media evaluated at SWMU 9 support a decision for no further action.

4.4.8 Ecological Risk Assessment

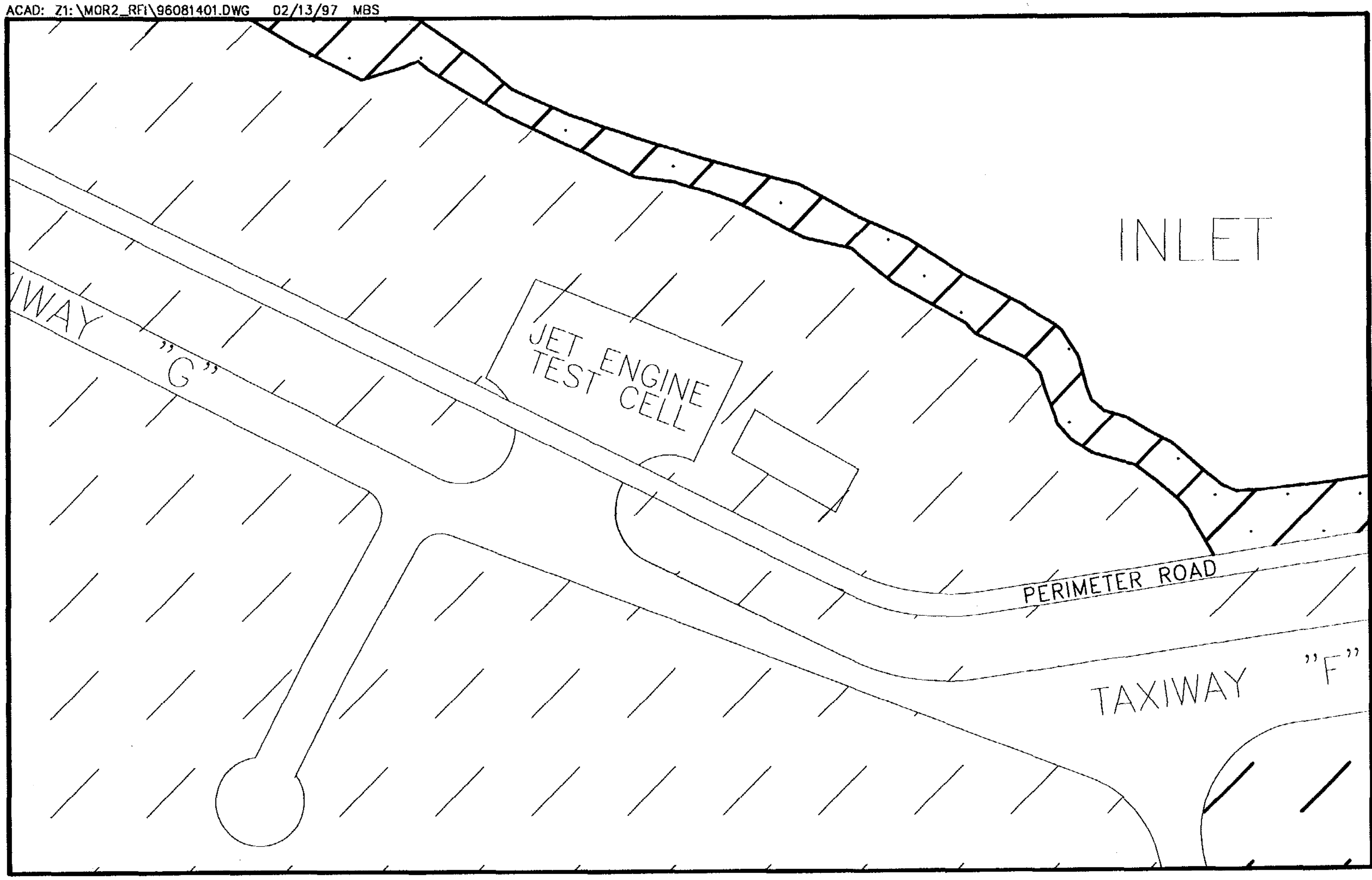
This section discusses the results of the ecological risk assessment performed at SWMU 9 through a discussion of the problem formulation, effects characterization, exposure assessment and risk characterization.

4.4.8.1 Problem Formulation

This section presents the ecological problem formulation through a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of ECPCs, assessment and measurement endpoints, and the conceptual site model.

4.4.8.1.1 Habitat Types and Ecological Receptors

Section 4.4.1 describes the physical setting at SWMU 9. Because most of the site is paved or developed, as are the areas to the south, it contains no significant terrestrial habitat (Figure 4-45). The mowed grass areas surrounding the east and west portions of SWMU 9 also provide no habitat. The grassy areas adjacent to the mowed areas provide habitat for terrestrial receptors such as small mammals. However, these grassy areas are occasionally mowed, reducing their value as terrestrial habitat. No signs of Lower Keys marsh rabbits have been observed in this area, and no marsh rabbits have been observed on or near the site (Schuetz, 1996). The inlet is relatively large and provides excellent aquatic habitat. Piscivorous birds such as herons and egrets forage in the shallow portions of the inlet. Although not observed during site visits, ospreys and bald eagles presumably forage at least occasionally in the inlet.



Brown & Root Environmental

0 150 300
SCALE IN FEET

LEGEND

- UPLAND/FILLED (MOWED OR EXOTICS)
- MIXED MANGROVE
- POND/NATURAL

FIGURE 4-45. HABITATS AT SWMU 9 JET ENGINE TEST CELL

NAS KEY WEST — KEY WEST, FLORIDA

DRAWN BY:	SCALE:	DATE:	REV:
MBS	–	08/08/96	0
CHECKED BY:	CONTRACT NO.:	FILE NAME:	
MLW	–	KEY WEST/T1/96081401.DWG	

4.4.8.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

The contaminant sources at SWMU 9 are the spill areas described in Section 4.4.1. The potential contaminant release pathways from the spill areas include combustion, volatilization, wind erosion, overland runoff, and infiltration of contaminants. Constituents in the site's soil can volatilize from surficial material or become airborne via resuspension. Contaminated fugitive dust can also be generated during ground-disturbing activities, such as construction or excavation. These contaminants are dispersed in the surrounding environment and transported to downwind locations where they can repartition to surface soil, surface water, or sediment through gravitational settling, precipitation, and deposition. However, most of the site and surrounding areas are paved, vegetated, or covered with water, minimizing airborne transport of contaminants. In addition, the surface area of the spill sites is relatively small, mitigating the airborne contaminant transport pathway.

Precipitation runoff can carry constituents to nearby surface waters, sediments, and surface soils, primarily to surface water and sediments in the inlet. Infiltrating precipitation can cause the contamination of subsurface soil and groundwater. Contaminants with a stronger tendency to adsorb to organic matter in a soil are expected to migrate at a slower rate. On infiltrating the soil column and reaching the water table, a contaminant can be carried with the flow of groundwater to downgradient locations. Groundwater at the site is shallow and probably is hydrologically connected to surface water in the inlet; as a consequence, contaminants can be deposited later in sediment or they can accumulate in the tissues of aquatic organisms.

4.4.8.1.3 Exposure Routes

Terrestrial receptors at SWMU 9 can be exposed to soil contaminants through incidental ingestion of soil and ingestion of contaminated food items. Animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation. Terrestrial receptors can also come in contact with contaminants in surface water by using surface water for drinking water, although this exposure route represents a negligible portion of total exposure for most receptors and site surface water has a high salt content. However, the areas of contaminated surface soil are small and are in an area of mowed grass. The excessive noise during jet engine testing also deterred use of habitat close to the site by terrestrial receptors, although testing was intermittent. For these reasons, terrestrial exposure routes at this site are present only to a minimal extent, and represent a negligible portion of total exposure.

Volatile constituents are present in some site soils, and soil-bound contaminant resuspension can occur. Combustion can also release contaminants into the air at SWMU 9. However, inhalation does not represent a significant exposure pathway because air contaminant concentrations are assumed to be quite low, even for burrowing wildlife. In addition, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors. In addition, the small areal extent of the spill areas results in minimal airborne contamination transport.

Aquatic and terrestrial organisms inhabiting the inlet can be exposed to contaminants through direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semiaquatic organisms can also be exposed to constituents in contaminated groundwater that flows into surface water.

4.4.8.1.4 Selection of Ecological Contaminants of Potential Concern

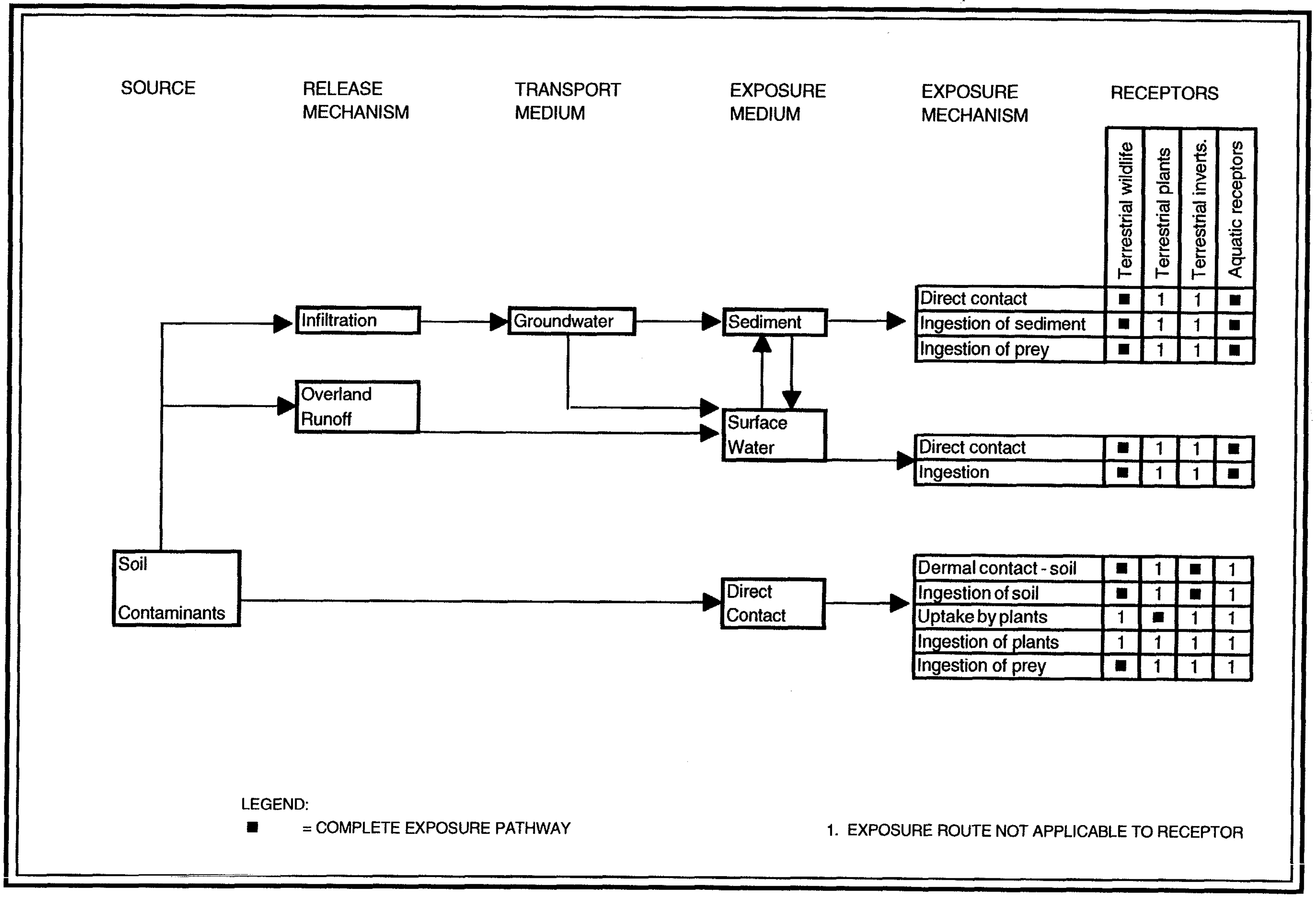
ECPCs were all contaminants detected in previous sampling and in Supplemental RFI/RI groundwater, surface water, sediment, and surface soil sampling at SWMU 9. However, calcium, iron, magnesium, potassium, and sodium were initially excluded as ECPCs in all media because they are essential nutrients that are toxic only in extremely high concentrations. In addition, inorganic contaminants whose maximum detected concentration was less than two times the average background concentration were excluded as ECPCs. This comparison to background is recommended by EPA (1996), because concentrations of inorganics can be naturally elevated and are not due to base-related contaminant releases.

4.4.8.1.5 Assessment and Measurement Endpoints

A detailed description of assessment and measurement endpoints for this investigation is presented in Section 3.3.1.1.6 of Appendix G.

4.4.8.1.6 Conceptual Site Model

The conceptual model is designed to identify potentially exposed receptor populations and applicable exposure pathways based on the physical nature of the site and the potential contaminant source areas. Actual or potential exposures of ecological receptors associated with the site were determined by identifying the most likely pathways of contaminant release and transport. A complete exposure pathway has three components: a source of contaminants that can be released to the environment; a route of contaminant transport through an environmental medium; and an exposure or contact point for an ecological receptor. Figure 4-46 shows the conceptual model for SWMU 9.



Exposure mechanism	Terrestrial wildlife	Terrestrial plants	Terrestrial inverts.	Aquatic receptors
Direct contact	■	1	1	■
Ingestion of sediment	■	1	1	■
Ingestion of prey	■	1	1	■
Direct contact	■	1	1	■
Ingestion	■	1	1	■
Dermal contact - soil	■	1	■	1
Ingestion of soil	■	1	■	1
Uptake by plants	1	■	1	1
Ingestion of plants	1	1	1	1
Ingestion of prey	■	1	1	1

Figure 4-46. Conceptual Site Model - SWMU 9, NAS Key West, Boca Chica Key, Florida

4.4.8.2 Ecological Effects Characterization

Ecologically based benchmarks, concentrations of contaminants in various media protective of ecological receptors, were selected to screen exposure point concentrations of ECPCs in groundwater, surface water, sediment, and soil to determine if they qualify as ECCs at SWMU 9. Groundwater contaminants were compared to surface-water screening levels for freshwater. Groundwater, surface-water, sediment, surface soil, and groundwater benchmarks are presented in Section 3.3.1 of Appendix G, where benchmark selection is discussed.

Toxicity tests were performed using surface water and sediment collected from SWMU 9. The toxicity of surface water was evaluated using the silverside minnow, mytilid mussel, and sea urchin, while the toxicity of sediment was evaluated using the mysid shrimp.

Mangrove oysters were collected from submerged prop roots of mangroves at the edge of the inlet north of SWMU 9 and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals. Concentrations of contaminants detected in the oysters were compared to concentrations in oysters collected from background site No. 3 (Table 4-108). Fish were not collected for tissue analyses from the inlet at SWMU 9 because the inlet is connected to the Gulf of Mexico. Thus, fish in the inlet are expected to be transient in character.

4.4.8.3 Exposure Assessment

This section presents the ecological exposure assessment for SWMU 9 through a discussion of exposure point contaminant concentrations and ecological dose calculations.

4.4.8.3.1 <u>Exposure Point Contaminant Concentrations</u>

Data used to obtain contaminant concentrations in environmental media at SWMU 9 were those generated from previous and current sampling activities. Maximum contaminant concentrations were used as representative concentrations in screening assessments of groundwater, surface water, sediment, and soil. Background values were obtained from several locations at NAS Key West. Background sampling is described in detail in Appendix J.

TABLE 4-108

CONCENTRATIONS OF ANALYTES DETECTED IN MANGROVE OYSTERS COLLECTED AT SWMU 9 DURING JANUARY 1996, COMPARED TO VALUES IN MANGROVE OYSTERS COLLECTED DURING THE SAME PERIOD FROM BACKGROUND SITE NO. 3 ALL VALUES ARE MILLIGRAMS PER KILOGRAM (PPM) NAS KEY WEST

Contaminant of Potential Concern	SWMU 9		Background 3		
	S9BV-01	S9BV-02	BG3BV-01	BG3BV-02	BG3BV-03
Arsenic	1.02	1.43	2.44	3.41	3.71
Barium	-	0.762	-	-	-
Copper	1.70	1.68	3.84	1.68	1.72
Lead	-	0.254	-	-	-
Mercury	-	-	0.077	0.061	0.046
Selenium	0.66	0.85	1.39	1.27	1.15
Silver	-	-	5.51	3.75	4.31
Zinc	617	881	1,570	582	647

4.4.8.3.2 Dose Calculations

Since exposure to surface soil and related contaminants is expected to be minimal at SWMU 9, dose calculations and food-chain modeling based on soil contaminant concentrations were not performed at the site.

4.4.8.4 Risk Characterization

This section presents the results and a discussion of the ecological risks at SWMU 9.

4.4.8.4.1 Results

The results of the ecological risk characterization at SWMU 9 are presented in this section with a discussion of the results from the Phase II ecological screening assessment, toxicity assessment, and tissue analyses.

4.4.8.4.1.1 Phase II Ecological Screening Assessment

The following chemicals were detected in groundwater at concentrations that exceeded surface-water benchmarks and were retained as ECCs: barium, cyanide, lead, selenium, silver, 1,1,2,2-tetrachloroethane, 1,1-dichloroethene, carbon tetrachloride, PCE, xylenes, bis(2-ethylhexyl)phthalate, naphthalene, 4,4'-DDT, dieldrin, and endrin (Table 4-109). Several organic compounds were conservatively retained as ECCs because no suitable benchmarks were available. In site surface water, cyanide and thallium exceeded benchmarks and were retained as ECCs and cobalt was retained as an ECC because no suitable benchmark was available (Table 4-110). In sediments, arsenic, cyanide, mercury, acetone, 4,4'-DDE, and delta-BHC exceeded benchmarks and were retained as ECCs, while selenium, vanadium, and methyl parathion were conservatively retained as ECCs because no suitable benchmarks were available (Table 4-111). In soils, aluminum, chromium, cyanide, mercury, and zinc exceeded benchmarks and were retained as ECCs (Table 4-112). No organic compounds in soil exceeded benchmark values.

TABLE 4-109

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 9
NAS KEY WEST
PAGE 1 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
INORGANICS						
Arsenic	3/8	4.33	5 - 8	50	0.16	Eliminated - does not exceed threshold
Barium	8/8	13.88	5.4 - 11.7	3.9	3.0	Retained - HQ > 1
Cyanide	5/8	2.76	0.83 - 6.6	5.2	1.27	Retained - HQ > 1
Lead	1/27	1.19	2.4	1.32	1.82	Retained - HQ > 1
Manganese	6/8	4.82	0.97 - 8.5	80	0.11	Eliminated - does not exceed threshold
Selenium	2/8	ND	4.9 - 6	5.0	1.2	Retained - HQ > 1
Silver	1/8	ND	6	0.07	85.7	Retained - HQ > 1
Vanadium	3/8	ND	0.89 - 4.4	19	0.23	Eliminated - does not exceed threshold
PESTICIDES/PCBs						
4,4'-DDT	1/8	ND	0.26	0.00059	440	Retained - HQ > 1
Beta-BHC	1/8	ND	0.03	0.046	0.65	Eliminated - does not exceed threshold
Delta-BHC	1/8	ND	0.43	500	0.00	Eliminated - does not exceed threshold
Dieldrin	1/8	ND	0.19	0.0019	100	Retained - HQ > 1
Endrin	1/8	ND	0.25	0.0023	108.6	Retained - HQ > 1
SEMIVOLATILE ORGANIC COMPOUNDS						
1,4-dichlorobenzene	9/39	ND	1 - 2	15	0.13	Eliminated - does not exceed threshold
1-methylnapthalene	5/20	ND	10 - 110	NA		Retained - no suitable threshold was available
2-methylnapthalene	3/28	ND	53 - 130	NA		Retained - no suitable threshold was available
Bis(2-ethylhexyl)phthalate	1/8	ND	9	0.3	30	Retained - HQ > 1
Chlorodibromomethane	8/47	ND	0.32 - 13.50	NA		Retained - no suitable threshold was available
Napthalene	13/57	4.09	2 - 110	62	1.77	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS						
1,1,1-trichloroethane	8/82	ND	2 - 13.50	62	0.22	Eliminated - does not exceed threshold
1,1,2,2-tetrachloroethane	7/82	ND	2 - 13.50	10.8	1.25	Retained - HQ > 1
1,1,2-trichloroethane	7/82	ND	2 - 13.50	62	0.20	Eliminated - does not exceed threshold
1,1-dichloroethane	7/82	ND	2 - 13.50	2,000	0.00	Eliminated - does not exceed threshold
1,1-dichloroethene	8/82	ND	2 - 13.50	3.2	4.20	Retained - HQ > 1
1,2-dichloroethene	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available
1,2-dichloroethene (total)	2/24	ND	25 - 35	NA		Retained - no suitable threshold was available
1,2-dichloropropane	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available

TABLE 4-109

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN GROUNDWATER - SWMU 9
NAS KEY WEST
PAGE 2 OF 2

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
VOLATILE ORGANIC COMPOUNDS (cont.)						
2-butanone	7/47	14.66	10 - 67.50	NA		Retained - no suitable threshold was available
2-hexanone	8/51	ND	2.32 - 67.50	NA		Retained - no suitable threshold was available
4-methyl-2-pentanone	7/51	ND	10 - 67.50	NA		Retained - no suitable threshold was available
Acetone	20/51	5	5 - 100	NA		Retained - no suitable threshold was available
Benzene	14/82	ND	1.60 - 56	71.28	0.79	Eliminated - does not exceed threshold
Bromodichloromethane	8/82	ND	0.20 - 13.50	NA		Retained - no suitable threshold was available
Bromoform	7/82	ND	2 - 13.50	293	0.05	Eliminated - does not exceed threshold
Bromomethane	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available
Carbon disulfide	10/51	ND	0.11 - 67.50	NA		Retained - no suitable threshold was available
Carbon tetrachloride	7/82	ND	2 - 13.50	4.42	3.05	Retained - HQ > 1
Chlorobenzene	7/82	ND	2 - 13.50	195	0.07	Eliminated - does not exceed threshold
Chloroethane	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available
Chloroform	8/82	ND	1.07 - 13.50	289	0.05	Eliminated - does not exceed threshold
Chloromethane	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available
Cis-1,2-dichloroethene	26/54	ND	2 - 1,560	NA		Retained - No suitable threshold available
Cis-1,3-dichloropropene	7/82	ND	2 - 13.50	24.4	0.55	Eliminated - does not exceed threshold
Ethylbenzene	11/82	ND	2 - 70	453	0.15	Eliminated - does not exceed threshold
Isopropyl alcohol	1/1	ND	23	NA		Retained - no suitable threshold was available
Methylene chloride	28/82	1.5	0.42 - 92.20	1,930	0.05	Eliminated - does not exceed threshold
Styrene	7/51	ND	10 - 67.50	NA		Retained - no suitable threshold was available
Tetrachloroethene	8/82	ND	0.07 - 13.50	8.85	1.53	Retained - HQ > 1
Toluene	12/82	ND	0.06 - 13.50	130	0.10	Eliminated - does not exceed threshold
Trans-1,2-dichloroethene	29/62	ND	2 - 3,060	NA		Retained - no suitable threshold available
Trans-1,3-dichloropropene	7/82	ND	2 - 13.50	24.4	0.55	Eliminated - does not exceed threshold
Trichloroethane	15/82	ND	1.50 - 44	NA		Retained - no suitable threshold was available
Trichlorofluoromethane	2/39	ND	3	NA		Retained - no suitable threshold was available
Vinyl acetate	9/51	ND	3 - 67.50	NA		Retained - no suitable threshold was available
Vinyl chloride	7/82	ND	2 - 13.50	NA		Retained - no suitable threshold was available
Xylenes (total)	10/82	ND	2 - 131.60	1.8	73.1	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-110

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SURFACE WATER - SWMU 9
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration (µg/L)	Range of Detected Values (µg/L)	Ecological Threshold (µg/L)	Hazard Quotient	Reason for Retention or Elimination as an ECC
HERBICIDES						
2,4-D	1/6	ND	0.13	100	0.0013	Eliminated - does not exceed threshold
INORGANICS						
Antimony	6/6	2.9	2.9 - 5.3	4,300	0.001	Eliminated - does not exceed 2 X background
Barium	6/6	9.05	6.7 - 7.3	10,000	0.0007	Eliminated - does not exceed 2 X background
Cobalt	1/6	ND	1.1	NA		Retained - no suitable threshold was available
Cyanide	1/6	1.56	45.2	1.0	45.2	Retained - HQ > 1
Mercury	1/6	0.12	0.13	0.03	5.2	Eliminated - does not exceed 2 X background
Nickel	1/6	ND	1.6	8.2	0.2	Eliminated - does not exceed threshold
Thallium	6/6	4.88	5.6 - 10.1	6.3	1.6	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

TABLE 4-111

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SEDIMENT - SWMU 9
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPC)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value[(1)]	Hazard Quotient	Reason for Retention of Elimination as an ECC
HERBICIDES (µg/kg)						
Methyl parathion	2/5	ND	14.8 - 38.8	NA		Retained - no suitable threshold was available
INORGANICS (mg/kg)						
Aluminum	5/5	2,041.75	774 - 3,710	NA		Eliminated - does not exceed 2 X background
Arsenic	2/5	1.71	12.6 - 17.8	7.24/70	2.46/0.25	Retained - HQ > 1
Barium	5/5	9.88	5.7 - 19.8	40	0.50	Eliminated - does not exceed threshold
Cadmium	3/5	0.42	0.28 - 0.62	0.68	0.92	Eliminated - does not exceed 2 X background
Chromium	5/5	6.94	3.3 - 11.6	52.3	0.22	Eliminated - does not exceed 2 X background
Copper	5/5	9.01	4.7 - 14.7	50	0.29	Eliminated - does not exceed 2 X background
Cyanide	1/5	ND	12.1	0.10	121	Retained - HQ > 1
Lead	5/5	24.65	6.4 - 23.1	30.2	0.76	Eliminated - does not exceed 2 X background
Manganese	5/5	21.95	6.2 - 17.1	460	0.04	Eliminated - does not exceed 2 X background
Mercury	1/5	ND	1.1	0.13/0.71	8.46/1.55	Retained - HQ > 1
Nickel	5/5	2.49	1.5 - 5	15.9	0.31	Eliminated - does not exceed threshold
Selenium	1/5	1.04	7.3	NA		Retained - no suitable threshold was available
Vanadium	5/5	4.84	4.7 - 13.2	NA		Retained - no suitable threshold was available
Zinc	5/5	30.4	12.5 - 38.3	124	0.31	Eliminated - does not exceed 2 X background
PESTICIDE/PCBs (µg/kg)						
4,4'-DDE	2/5	ND	6.4 - 14.3	1.22/27	11.7/0.5	Retained - HQ>1
Delta-BHC	2/5	ND	11.3 - 14.2	3	4.7	Retained - HQ > 1
VOLATILE ORGANIC COMPOUNDS (µg/kg)						
Acetone	2/5	34.3	275 - 1,890	64	29.53	Retained - HQ > 1

NA = No suitable ecological threshold value was available.
ND = Not detected.

1 When two values are presented, the left value is the most conservative available and the right value is a less conservative value, if available. In these instances, two HQ values are presented. Contaminants were retained as final ECPCs if the most conservative ET value available was exceeded.

TABLE 4-112

ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN IN SOIL - SWMU 9
NAS KEY WEST

Ecological Contaminants of Potential Concern (ECPCs)	Frequency of Detection	Average Background Concentration	Range of Detected Values	Ecological Threshold Value	Hazard Quotient	Reason for Retention of Elimination as an ECC
INORGANICS (mg/kg)						
Aluminum	5/5	2,130	1,170-4,790	600	7.98	Retained - HQ > 1
Barium	5/5	11.0	14.5-46.8	440	0.11	Eliminated - does not exceed threshold
Cadmium	2/5	0.17	2.1-7.15	20	0.36	Eliminated - does not exceed threshold
Chromium	5/5	6.22	7.2-69.55	0.4	174	Retained - HQ > 1
Cobalt	5/5	0.34	0.33-1.3	200	0.007	Eliminated - does not exceed threshold
Copper	5/5	5.28	6.9-49.6	50	0.99	Eliminated - does not exceed threshold
Cyanide	2/5	ND	2.2-2.6	0.005	520	Retained - HQ > 1
Lead	5/5	16.8	7.4-264.95	500	0.53	Eliminated - does not exceed threshold
Manganese	5/5	19.4	12.4-66.4	100	0.66	Eliminated - does not exceed threshold
Mercury	2/5	0.03	0.06-0.32	0.1	3.20	Retained - HQ > 1
Nickel	5/5	1.63	3.6-6.6	200	0.03	Eliminated - does not exceed threshold
Silver	3/5	ND	1.16-4.6	50	0.09	Eliminated - does not exceed threshold
Vanadium	5/5	3.71	4.45-14.8	20	0.74	Eliminated - does not exceed threshold
Zinc	5/5	19.0	16.5-298.5	200	1.49	Retained - HQ > 1
PESTICIDES/PCBs (μg/kg)						
4,4'-DDE	2/6	12.38	9.0-15.1	100	0.15	Eliminated - does not exceed threshold
4,4'-DDT	1/6	7.62	2.3	100	0.02	Eliminated - does not exceed threshold
Endosulfan I	1/6	ND	7.9	100	0.08	Eliminated - does not exceed threshold
Endrin	1/6	ND	5.1	100	0.05	Eliminated - does not exceed threshold
VOLATILE ORGANIC COMPOUNDS (μg/kg)						
Toluene	1/5	1.71	5.0	100	0.05	Eliminated - does not exceed threshold

ND = Not detected.

4.4.8.4.1.2 Toxicity Tests

Survival of silverside minnows in surface water from this site was slightly (but not significantly) lower than survival in laboratory controls in all five samples from this site (Table 4-113). Survival and growth of mysid shrimp in sediment, fertilization and development of mussel larvae, and sea urchin fertilization from this site were similar to laboratory control values for those tests.

4.4.8.4.1.3 Tissue Analyses

Mangrove oysters were collected from submerged prop roots of mangroves at the edge of the inlet north of SWMU 9. Due to the small amount of soft tissue in this species, the total mass of tissue extracted from the oysters was sufficient for only two samples for laboratory analyses. No VOCs, SVOCs, pesticides, or PCBs were detected in these two samples. Metals detected in at least one of the two samples consisted of arsenic, barium, copper, lead, selenium, and zinc (Table 4-108).

4.4.8.4.2 Discussion

Several metals and organic compounds were detected in groundwater and were conservatively retained as ECCs because no suitable surface water benchmarks were available for those contaminants. Where benchmarks were available, the resulting hazard quotients were generally indicative of low potential risk. The hazard quotients for silver, DDT, dieldrin, and endrin were quite high, but each of these contaminants was detected in only one of eight samples.

Although groundwater is not available to ecological receptors, it could become available by discharging to surface water or sediment. If this migration pathway existed to a significant extent at SWMU 9, the contaminants identified as ECCs in groundwater would be present at elevated levels in surface water or sediment. The relatively low contaminant concentrations in surface water and sediment in the inlet suggests that this is presently not occurring at SWMU 9. However, potential risks resulting from future groundwater migration to surface water or sediment might be possible.

Only a few contaminants in surface water and sediment were identified as ECCs, and the resulting hazard quotients were indicative of low risk, with the exception of cyanide. However, the frequency of detection of cyanide was low (one of six in surface water, one of five in sediment). Furthermore, the presence of cyanide is not believed to be a result of activities at SWMU 9.

TABLE 4-113

TOXICITY TEST RESULTS - SWMU 9
NAS KEY WEST

Test Type and Endpoint	Sample					
	Control	1	2	3	4	5
Sea urchin fertilization test (% eggs fertilized)	99.7	100.0	100.0	100.0	99.7	99.7
Mussel 48-hour larval development (% normal)	96.5	96.3	94.6	96.3	94.5	88.0
Silverside minnow 96-hour acute toxicity test (% survival)	100	95	75	85	90	90
Mysid shrimp 10-day sediment toxicity test (% survival and total growth in mg)	86.7(1)	85.0	90.0	85.0	100.0	85.0
	0.252(2)	0.266	0.306	0.238	0.236	0.276

1 % survival.
2 Total growth in milligrams (mg).

Five metals exceeded benchmark values in site soils. Of these, cyanide and chromium had hazard quotients indicative of potentially high risks to terrestrial receptors. Chromium was detected in all five surface soil samples. Although Table 4-112 lists a wide range of chromium concentrations (7.2 to 69.55 mg/kg), only one sample exceeded 15.1 mg/kg. Nevertheless, all detected values exceeded the average background concentration of 6.22 mg/kg. The source of chromium in all soil samples is unknown. Chromium was not detected in groundwater or surface water, and was present in sediment at concentrations well below ecological benchmarks. Thus, it does not appear to pose potential risks to aquatic receptors. The risk of chromium and the other soil ECCs to terrestrial receptors is largely mitigated by the overall lack of terrestrial habitat at this site. As mentioned earlier, the site is largely a developed area of buildings and mowed grass.

In toxicity tests conducted with surface water and sediment taken from the inlet adjacent to the site, the survival and growth of mysid shrimp, the fertilization and development of mussel larvae, and sea urchin fertilization were similar to control values. The survival of silverside minnows was 95, 75, 85, 90, and 90 percent in Sample Nos. 1, 2, 3, 4, and 5, respectively (Table 4-113). The 75 percent survival in Sample No. 2 was somewhat lower than in laboratory controls. The salinity of Sample No. 2 was 34 ppt, slightly higher than the 32 ppt maximum value recommended in toxicity tests using this species. The survival of laboratory control minnows was extraordinarily high (100 percent); thus the slightly reduced survival in four of five SWMU samples (when compared to laboratory controls) does not appear to have been a treatment effect. Because all other toxicity tests conducted with surface water and sediment from this site indicated normal survival and growth, the reduced survival in Sample No. 2 in the silverside minnow toxicity tests is not believed to be a treatment effect. In summary, the toxicity tests indicate that potential risks to aquatic receptors in the inlet appear to be low.

Concentrations of metals in mangrove oysters collected from the inlet were similar to concentrations in mangrove oysters collected from one background site (oysters were not available at the other two background sites). No organic compounds were detected in oyster tissue from SWMU 9. Therefore, although the available number of samples was low, results of the tissue analyses show no indication of contaminant accumulation in these filter feeding organisms.

4.4.8.5 Ecological Risk Assessment Summary

Numerous organic compounds have been detected in groundwater at SWMU 9. Although migration of these contaminants to the nearby inlet does not appear to have occurred, the potential for ecological risks from future groundwater contaminant migration to surface water or sediment cannot be totally ruled out, despite the potential for some dilution on discharge to surface water. For this reason, it is recommended that site groundwater be treated to reduce the concentration of these organic compounds and thus reduce the possibility of future site-related risks to aquatic receptors. The results of surface-water and sediment screening assessments, toxicity tests, and tissue analyses show that, under present conditions, risks to aquatic receptors from site-related activities are negligible. Although a few soil contaminants exceeded benchmark values, the risks to terrestrial receptors posed by these contaminants are negligible due to the limited areal extent of contaminated soil and the marginal habitat in the area where fuel and solvents were spilled.

4.4.9 Conclusions and Recommendations

Fuel oil and solvent-related VOC, chlorinated VOC, and SVOC constituents at low levels have been found in groundwater and soil at SWMU 9. Surface-water and sediment contaminants found at the shoreline of the inlet on the northern edge of the site were largely metals and other inorganics. The most significant contaminants present at SWMU 9 are in groundwater with contaminant plumes of benzene and 1,2-dichloroethene identified in the eastern part of the site by the 1994 ABB investigation. In 1995, a BEI study confirmed the presence of both of these plumes, although spreading more in a northwest direction rather than northeast, as measured in 1995. Groundwater contaminant concentrations decreased from 1994 to 1995, and this reduction has continued in the 1996 measurements.

Chromium was detected in all surface soil and subsurface soil samples.

The estimated carcinogenic risks for future residents (6E-05), adult trespassers (1E-05), and adolescent trespassers (1E-05) are with EPA's target risk range of 1E-04 to 1E-06. The other use scenarios pose a cancer risk well below the EPA target risk range. The calculated noncarcinogenic risk for future residents slightly exceeds 1, a benchmark below which adverse noncarcinogenic health effects are not anticipated. The noncarcinogenic human health risk posed by the other scenarios was below the benchmark.

Similarly, the ecological risk assessment concluded no current ecological hazard at SWMU 9. VOCs have been detected in groundwater in SWMU 9 and, although migration of these contaminants to the nearby inlet has not occurred based on benthic monitoring, the potential for future ecological risks from contaminant migration in groundwater to the surface water or sediment exists. SWMU 9 is currently undergoing groundwater treatment through a pump-and-treat system that was installed and started in July 1996. If this system is effective, future ecological risks would be satisfactorily mitigated. Ecological risks to terrestrial receptors posed by surface contaminants at the site were judged to be negligible due to the limited extent of contaminants in the soil and the marginal habitat in the immediate area of the site.

In summary, although no ecological risks are posed by the site, the borderline human health risks posed by COPCs and the presence of contaminants in excess of screening action levels in groundwater warrants the preparation of a corrective measure study. At a minimum, this study should evaluate the interim remedial measure currently being operated at SWMU 9, which includes a groundwater pump-and-treat system and future ecological benthic monitoring of the inlet adjacent to SWMU 9 as an alternative. Although it would need to be confirmed by the corrective measure study, the anticipated need for future remediation at the site in addition to that already implemented is unlikely, unless the existing groundwater remediation system proves ineffective.

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